

CGW:FJM
VII-3

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
WASHINGTON

Letter
Circular
LC-690
(Supersedes
LC-543)

(April 22, 1942)

PAPER AND RELATED SUBJECTS: PUBLICATIONS BY MEMBERS
OF THE STAFF OF THE NATIONAL BUREAU OF STANDARDS

C o n t e n t s

	Page
A. Papermaking materials and processes	A-10
1. Fibrous materials	A-10
2. Nonfibrous materials; coating minerals and adhesives, fillers, pigments, sizings, etc.	A-20
3. Manufacturing processes	A-30
B. Properties and testing of paper	B-10
1. General	B-10
2. Chemical properties	B-20
3. Physical (mechanical)	B-30
4. Microscopic examination	B-40
5. Optical examination	B-50
6. Resistance to liquids and gases	B-60
7. Hygrometry in paper testing	B-70
C. Use of paper in printing	C-1
D. Permanence and preservation	D-10
1. Stability of paper	D-10
2. Preservation	D-20
E. Standardization	E-10
1. Quality studies of materials	E-10
2. Specifications and standards	E-20
F. Miscellaneous	F-10
1. Utilization of waste liquors	F-10
2. Miscellaneous articles on paper and allied subjects	F-20
3. Lists of other Bureau publications	F-30

GENERAL INFORMATION

Types of Work

The Paper Section of the Organic and Fibrous Materials Division at the National Bureau of Standards studies the standardization of paper and the materials and processes used in its manufacture. The work leads to formulation of standards of quality, and includes, necessarily, the development of means by which quality can be determined. For research related to the manufacture of paper, the section is equipped

with laboratory and semi-commercial papermaking facilities. These are used to obtain information which will assist the paper maker in achieving the desired qualities in paper at a minimum of cost, in developing new or improved paper products, and in utilizing new fibrous raw materials, particularly waste materials.

General Scope of Bureau Work

The National Bureau of Standards is charged with the development, construction, custody, and maintenance of reference and working standards, and their intercomparison, improvement, and application in science, engineering, industry, and commerce. The Bureau is organized in three principal groups -- research and testing; commercial standardization; administrative work, operation of plant, and construction of laboratory instruments and apparatus. The following divisions comprise the Research and Testing group: Electricity, Weights and Measures, Heat and Power, Optics, Chemistry, Mechanics and Sound, Organic and Fibrous Materials, Metallurgy, Clay and Silicate Products. The Commercial Standardization group consists of three divisions: Simplified Practice, Trade Standards, and Codes and Specifications.

Description of List

Publications not listed are those which have become more or less obsolete through being superseded by later publications or because they contain information of temporary value only. The publications are listed in chronological order and are arranged in groups dealing with the same general subject.

How to Obtain Publications

The reports of the investigations are published either in Government publications or in outside publications. The Bureau usually receives reprints of the articles published outside and furnishes those available free of charge. Copies of the publications can be consulted in many of the larger libraries.

Where the price is stated, the publication can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C. The prices quoted are for delivery to addresses in the United States and its territories and possessions and in certain foreign countries which extend the franking privilege. In the case of all other countries, one-third the cost of the publication should be added to cover postage. Remittances should be made either by coupons (obtainable from the Superintendent of Documents in sets of 20 for \$1.00 and good until used), or by check or money order payable to the "Superintendent of Documents, Government Printing Office" and sent to him with order.

Articles marked "OP" are out of print and reprints are no longer available. Many of the articles are published in more than one journal and references to journals in addition to those given may be found in "The Bibliography of Paper Making" by C. J. West, published by the Lockwood Trade Journal Co., which is available in most libraries.

Serial letters are used to designate Bureau publications:

- RP - "Research Paper". These are reprints of articles appearing in the "Bureau of Standards Journal of Research" (BS J. Research) and the "Journal of Research of the National Bureau of Standards" (J. Research NBS), the latter being the title of this periodical since July 1934 (volume 13, number 1).
- T - "Technologic Paper" of the National Bureau of Standards. Numbers 1 to 202 were issued each independent of the other with individual pagination. Later they were assembled to make the first 15 volumes of this series, and subsequent separates were given volume pagination. (Tech. Pap. BS.) This series was superseded by the "Bureau of Standards Journal of Research" in 1928.
- C - "Circular" of the National Bureau of Standards.
- M - "Miscellaneous Publication" of the National Bureau of Standards.
- LC - "Letter Circular" of the National Bureau of Standards. Copies available free upon application to the Bureau.
- BMS - "Building Materials and Structures" reports of the National Bureau of Standards.

For papers in other scientific or technical journals, the name of the journal or of the organization publishing the article is given in abbreviated form, together with the volume number (underscored), page, and year of publication, in the order named.

Outside Publications Cited

Envelope Industry (discontinued).
 India Rubber World, 420 Lexington Avenue, New York, N. Y.
 Paper (discontinued).
 Paper Industry, 333 N. Michigan Avenue, Chicago, Illinois.
 Paper Mill News, 1440 Broadway, New York, N. Y.
 Paper Trade Journal, Lockwood Trade Journal Co., 15 W. 47th Street, New York, N. Y.

Tech. Assoc. Papers, Technical Association of the Pulp and
Paper Industry, 122 East 42nd Street, New York, N. Y.
Food Industry, McGraw-Hill Book Co., New York, N. Y.
Journal of Documentary Reproduction, American Library Associ-
ation, 520 N. Michigan Avenue, Chicago, Illinois.
Refrigerating Engineering, 37 W. 39th Street, New York, N. Y.
Heating, Piping, and Air-Conditioning, 6 N. Michigan Avenue,
Chicago, Illinois.

A. PAPERMAKING MATERIALS AND PROCESSES

1. Fibrous Materials

<u>Title</u>	<u>Series</u>	<u>Price</u>
Studies of paper pulps. W. H. Smith. Tech. Pap. BS, T38 (1917).	T38	OP

Samples of paper pulps, each representing a different method of preparation and with one exception of American manufacture, have been examined to determine their chemical properties. These consist of the amount of ash, cellulose and methoxyl, the yield of furfural and methyl-furfural, and the copper number. Using the same pulps, the loss in weight produced by reagents causing oxidation and hydrolysis, and the increase in weight when nitrated have been determined. The effects of sunlight, temperature, and ozonized air on the chemical constants obtained with groundwood have been ascertained.

Seed flax straw as papermaking material. E. H. Kellogg, M. B. Shaw and G. W. Bicking. Paper Trade J. 77, No. 5, 42 (Aug. 2, 1923).

Owing to the immense quantities of seed flax available, most of which is at present wasted, this material has attracted considerable attention as a source of papermaking fiber. An investigation of its use for this purpose was made, using both the whole straw and the tow. The material was pulped by the sulphate process. Pulping tests made in the experimental mill were repeated in a commercial mill to obtain reliable cost data. The pulp obtained from both sources was made into paper on the experimental paper machine.

The results indicate that there would be no difficulty in producing papers equal in quality to those obtained from wood. The cost data show, however, that at the present time both the initial cost and the cost of conversion of flax straw would be greater than that of wood.

Cotton stalks as papermaking material. M. B. Shaw, G. W. Bicking and R. R. Rumsey. Paper Trade J. 81, No. 5, 50 (July 30, 1925); World's Paper Trade Rev. 84, No. 21, 1634 (Nov. 20, 1925).

Severe chemical treatment and long cooking time were required for pulping. The yield of fiber was good but the paper had poor quality, being suitable only for low grade wrapping or board. The results indicate that this material is not commercially feasible for making paper, at least if the ordinary papermaking methods are used.

<u>Title</u>	<u>Series</u>	<u>Price</u>
Esparto as a papermaking material. M. B. Shaw, G. W. Bicking and R. R. Rumsey. Paper Trade J. <u>81</u> , No. 12, 55 (Sept. 17, 1925).		
Papermaking tests were made on a semi-commercial scale of a partially pulped stock being offered for import from abroad. It yielded 57 to 63 percent of easy bleaching pulp suitable for book and other papers of a similar nature, a mild cooking treatment being required. The fiber was appreciably stronger than that of soda wood pulp, approaching sulphite wood fiber in strength.		
<u>Stipa ichu</u> grass as a papermaking material. M. B. Shaw and G. W. Bicking. Paper Trade J. <u>83</u> , No. 18, 105 (Oct. 28, 1926).		
Tests on <u>stipa ichu</u> grass from Ecuador were made to determine the value of the material as a potential source of paper pulp. The tests were limited to laboratory-scale production and consisted of the usual papermaking processes. The sheets made were submitted to the various physical tests applied in evaluation of paper. Two cooking processes were included: one employing 25 percent of caustic soda; the other 25 percent of lime. The yield of unbleached pulp was 25.5 and 56.6 percent, respectively. The pulp from the caustic cook was difficult to bleach and that from the lime was deficient in strength. On account of the low yield, high chemical consumption, and lack of strength, ichu grass is not considered satisfactory papermaking material. It gives a soft and bulky sheet, and is, however, doubtless suitable for use as filler with the stronger fibered pulps.		
Manila rope waste for paper manufacture. M. B. Shaw and G. W. Bicking. Paper Trade J. <u>84</u> , No. 18, 68 (May 5, 1927).		
Experimental papermaking tests were made to determine the suitability of manila rope waste for paper manufacture. The waste employed was the refuse fiber from the manufacture of manila cordage at the rope walk of the Boston Navy Yard. The tests were made at the request of the Bureau of Construction and Repair with a view to finding a market for the rope waste of the Navy Department. The tests were on both laboratory and semi-commercial scale. Different cooking agents were employed in the pulping operation. Kraft and sulphite wood pulps and old rope stock are included for comparison. The results indicate that soda ash is the digesting agent that gives best results, both as to yield of pulp and quality of paper produced. The waste does not compare favorably with old rope stock but is considerably better than sulphite wood pulp and seems worthy of consideration as a papermaking material.		

TitleSeries Price

Waste mail pouches as papermaking material. M. B. Shaw and G. W. Bicking. Paper Trade J. 84, No. 19, 45 (May 12, 1927).

Semi-commercial tests were made to determine the paper-making value of waste mail pouches declared unserviceable for postal use. Owing to the unavoidably dirty condition of worn pouches the market price of the refuse material has been relatively low. As a result the General Supply Committee requested the tests with a view to securing for the condemned material a price commensurate with its papermaking quality. A good grade of clean half stuff was obtained from the waste by the caustic soda and the lime - soda ash processes. The paper produced was stronger than that made from sulphite wood stock and compared favorably with many of the high-grade bond and rag writing papers on the market.

Caroa fiber as a papermaking material. M. B. Shaw and G. W. Bicking. Tech. Pap. BS 21, 323 (1926-27). T340 25¢

Laboratory and semi-commercial mill tests have been made to determine the papermaking qualities of caroa fiber. The tests have shown the material to be very suitable for the production of paper, especially for use with or as a substitute for rag and rope stock, of which there is a scarcity at the present time. Caroa is a South American plant now little used commercially but production and cost estimates indicate that its use for papermaking would be practical. The caustic soda process was employed in preparing the pulp. There was made unbleached paper of unusual strength suitable for bag or wrapping purposes, and bleached paper that compared favorably with papers made from rag stock. The chemical consumption and yield of pulp were satisfactory. A comparative micrographic study was included in the investigation.

Rayon as a papermaking material. M. B. Shaw and G. W. Bicking. BS J. Research 4, 203 (1930). RP143 5¢

Laboratory tests were conducted to determine the paper-making value of rayon when treated the same as rags are in the production of fine papers. Owing to loss of strength when wet, the rayon filaments tended to break into short lengths during the preparation of the papermaking stock without the fibrillation and fraying necessary for good felting properties. As a consequence the all-rayon paper lacked the strength to withstand the handling required in the pressing and drying operations, and the softness and pliability characteristic of rag papers. Sheets made of rayon in admixture with sulphite pulp were also considerably weaker than those made from sulphite alone. The test data indicate that rayon is valueless in the rag stock for high-grade papers and may actually be detrimental to their quality.

<u>Title</u>	<u>Series</u>	<u>Price</u>
The papermaking properties of phormium tenax (New Zealand Flax). M. B. Shaw, G. W. Bicking and M. J. O'Leary. BS J. Research 6, 411 (1931). Experimental laboratory and semi-commercial papermaking tests were made to ascertain the suitability of phormium tenax (New Zealand Flax) fiber for paper manufacture. In a number of the tests the preparation of the pulp included two successive cooking operations, fractional digestion. Either the caustic soda digestion process or two stage cooks using sodium sulphite and caustic soda, respectively, gave very good results, on the basis of both quality of fiber produced and yield obtained. The experimental data indicate that phormium tenax is a promising material for wrapping or writing papers, but that it needs to be thoroughly cleaned mechanically before being submitted to the papermaking operations.	RP285	10¢
Highly purified wood fibers as papermaking material. R. H. Rasch, M. B. Shaw and G. W. Bicking. BS J. Research 7, 765 (1931). Studies were made in the Bureau paper mill of the paper-making qualities of highly-purified wood fibers with particular reference to their use for permanent record and currency paper. They were found to produce papers having high strength, stability, opacity, and other properties necessary for such purposes. Study of the variables in the usage of the paper sizing materials showed that alum and rosin decreased the stability of the papers unless the amounts used were very carefully controlled, but that starch and glue used for surface sizing improved the stability. The fibers studied were a commercial product characterized by high alpha cellulose content, low copper number, and high strength.	RP372	OP
The papermaking quality of cornstalks. C. G. Weber, M. B. Shaw and M. J. O'Leary. Misc. Pub. NBS, M147 (1935). This investigation was made to determine the practical possibilities of utilizing cornstalks, a waste farm product, for paper. Pulping difficulties presented by structural characteristics of the plant were overcome by special mechanical preparation, and the material was pulped without difficulty by both the sulphate and caustic soda processes. The fibers are not strong enough for use in brown wrapping papers, but bleached pulp suitable for writing paper and greaseproof specialties was obtained by the caustic soda process. Yields were very low, making raw materials and processing costs comparatively high.	M147	5¢

<u>Title</u>	<u>Series</u>	<u>Price</u>
A study of the relation of some properties of some cotton rags to the strength and stability of experimental papers made from them. M. B. Shaw, G. W. Bicking and M. J. O'Leary. J. Research NBS <u>14</u>, 649 (1935). Experimental high-grade bond papers were made in the semi-commercial paper mill of the Bureau from new and from old rags to obtain information on the factors affecting the strength and stability of rag-fiber papers. The data show that high acidity resulting from excessive use of alum in rosin-sizing had a marked deteriorative effect upon these papers. The pH value for optimum results as far as stability is concerned was approximately 5.0. Of papers of the same acidity those having the lesser content of rosin were the more stable. The study shows that careful processing of raw materials in respect to active chemical components (alum, rosin, etc.) is necessary for the manufacture of stable papers.	RP794	10¢
A study of the weathering quality of roofing felts made from various fibers. O. G. Strieter. J. Research NBS <u>16</u>, 511 (1936). Results of investigation to determine the relative effect of different fibers on the life and serviceability of asphalt saturated and coated felts. Experimental felts were made for the study. The materials used were No. 2 roofing rags, old jute and manila bagging, waste paper, sulphite pulp, and sawdust. There was no significant difference in the resistance to weathering of the samples that could be attributed to the kind of fibers employed.	RP888	OP
Study of the effect of fiber components on the stability of book papers. M. B. Shaw and M. J. O'Leary. J. Research NBS <u>17</u>, 859 (1936). Supplementing previously reported studies relating to the permanence of writing papers used for records, this article reports the results of experimental papermaking tests of a number of pulps commonly used in book papers. The pulps ranged in quality from 78 to 93 percent alpha cellulose and 3.8 to 0.4 copper number. The composition of the beater furnishes was 85 percent fiber and 15 percent clay. The test results showed close relation between the cellulosic purity of the pulps and the stability of the experimental unsized papers made from them.	RP949	5¢

2. Nonfibrous Materials; Coating Minerals and

Adhesives, Fillers, Pigments, Sizings, etc.

<u>Title</u>	<u>Series</u>	<u>Price</u>
Recovery of paraffin and paper stock from waste paraffin paper. W. H. Smith. Tech. Pap. BS, T87 (1916).	T87	OP

In order to recover the paraffin and paper stock in waste paraffin paper, a process is described utilizing a vertical steam boiler, tanks for receiving the paraffin, and a beater. The waste is pulped with exhaust steam. The wax rises to the surface and the paper stock settles in the boiler. In the beater the stock is treated with an alkaline solution in hot water to remove ink. The residual wax is collected on a metal cylinder, internally water chilled, and partly submerged in the hot water of the beater. Paper prepared from the recovered stock was free from wax and entirely satisfactory. Practically all of the paper stock is recovered, but about 10 percent of the paraffin is lost.

Rubber latex in paper. The effect of adding rubber latex to the beater in the experimental manufacture of book and wrapping paper. M. B. Shaw and G. W. Bicking. Paper Trade J. 75, No. 26, 53 (Dec. 28, 1922).

This work gives first the claims made by F. Kove, the inventor of the process of adding rubber latex to paper. This is followed by a discussion of the source, characteristics and method of analysis of the latex. Test runs were made on one and two percent rubber. The data did not show any definite improvements in paper to which latex had been added, the differences being those ordinarily found in any paper. There was a slight increase in bursting strength on book papers. The paper having latex in it seemed to be better sized and to take the better finish. There was no increased retention of clay due to the addition of latex.

Aging of rubber latex paper. M. B. Shaw and F. T. Carson. India Rubber World 68, No. 3, 561 (June 1, 1923).

Successive analyses of the same papers with increasing age indicates a comparatively rapid oxidation of the rubber retained in paper as a result of adding latex to the beater furnish. Within the limits of the investigation, the oxidation was observed to be most rapid in the case of paper made of sulphite and soda pulp and least rapid in the case of rag papers. Complete oxidation in the case of the former was a matter of a few days, while in the latter case several months were required for the greater part of the rubber to oxidize.

<u>Title</u>	<u>Series</u>	<u>Price</u>
Comparison of American and foreign clays as paper fillers. M. B. Shaw and G. W. Bicking. Tech. Pap. BS <u>18</u> , 337 (1924-25); In part in Paper Trade J. <u>79</u> , No. 18, 119; No. <u>22</u> , 77 (October 30 and Nov. 27, 1924).	T262	OP

The purpose of this investigation was to ascertain the relative merits of American and foreign clays for use as paper fillers. The comparative study included the amount of clay retained in the paper, the quality of the paper produced, and those physical properties of the clay (grit, etc.) that might affect the paper manufacturing processes. Measurements for clay retention include analyses of samples taken at 13 different positions on the paper machine. The results show that the amount of clay retained in the finished paper and the quality of the paper, in general, are the same for both American and foreign clays. The color and grit tests favor very slightly the foreign clays, but not sufficiently to justify the consideration of only these properties in selecting clays.

Use of glue in paper coating. V. H. Gottschalk. Paper Trade J. 79, No. 20, 46 (Nov. 13, 1924). OP.

Gives results of experiments on clay coating of paper using animal glues of different grades as binder. The relative amounts of glue and casein used in the coating formula are contrasted. The effect of diluting the coating mixture is discussed and a probable connection between this dilution and the mottling in the finished paper pointed out. A summary of color measurements of glue-bound coated paper is included. Some consideration is given the water-resistance and printing qualities of coated paper, and the specifications for coaters glue.

A comparative study of paper fillers. M. B. Shaw and G. W. Bicking. Tech. Pap. BS <u>19</u> , 733 (1924-25).	T301	OP
--	------	----

Commercial paper fillers consisting of asbestine, talc, clay, crown filler and gypsum were studied to determine their comparative papermaking value, the tests being made in the semi-commercial Bureau mill. The chief difference found was in degree of retention. Because of greater solubility of crown filler and gypsum, they gave lower retentions in the paper than the other materials. The papermaking processes were not adversely affected by any of the materials used. Values for chemical composition and physical characteristics are included for each material.

TitleSeries Price

Consideration of glue bound coated paper. G. K. Hamill.

Paper Trade J. 82, No. 8, 247, 249, 251 (Feb. 25, 1926);
Tech. Assoc. Papers 2, 77 (June 1926).

Earlier cooperative work by the Bureau of Standards and the National Association of Glue Manufacturers has been continued to include a study of satin white and blanc fixe as coating minerals. No difficulties were encountered in using these materials with glue as the adhesive. The amounts of tanning materials which may be added to glue containing coating mixtures, to increase the water resistance of the coated papers, vary with the grade and type of glue chosen and are largely influenced by the other materials used. With coating mixtures based on medium-grade glues optimum viscosity and working life were obtained at about 85° F. Considerable attention has been paid to the problems of printing coated papers. The need for closer cooperation between paper manufacturers, ink manufacturers, and printers is stressed.

Surface sizing of paper with glue. G. K. Hamill, V. H.

Gottschalk and G. W. Bicking. Paper Trade J. 83, No. 23, 39 (Dec. 2, 1926).

Growing interest among manufacturers and consumers in the permanence of paper and in improvement of strength and printing qualities of papers as related to surface sizing processes has led to a cooperative study of surface sizing by the Bureau of Standards, the Bureau of Efficiency, and the National Association of Glue Manufacturers. The results indicate that with any given paper (1) the bursting strength increases with increased retention of the glue; (2) the folding endurance increases at first with increasing glue content and then decreases; (3) the resistance to water and to wet rubbing of glue-sized papers may be markedly increased by treatment with glue hardening materials such as formaldehyde; (4) the folding endurance of either unsized, rosin sized, or surface sized papers may be increased by the addition of softening agents such as glycerine; and (5) that the effects of glycerine treatment as ordinarily applied are short lived.

Glue as beater sizing. G. K. Hamill, M. B. Shaw and G. W.

Bicking. Paper Trade J. 84, No. 3, 38 (Jan. 20, 1927).

Because of the possibility of improving certain desirable qualities of papers, especially of those types made from the lower priced fibers and containing mineral fillers, various methods of using glue in the beater sizing of paper were studied. Optimum operating conditions and maximum retentions of glue, comparing favorably with those of the clay used, were obtained when the hydrogen-ion concentration was so controlled

<u>Title</u>	<u>Series</u>	<u>Price</u>
that the pH value approximated 4.5. In general, it was found that in papers sized with glue and rosin the strength is frequently, and the degree of sizing is generally, improved as compared with similar papers sized with rosin alone. These improvements were most noticeable in papers containing clay filler. The chief influence of glue on the various types of papers seemed to be to enhance such intangible properties as firmness and handling qualities.		

Water resistance of mineral coated papers. G. K. Hamill.

Paper Trade J. 34, No. 8, 146 (Feb. 24, 1927).

In studying improvements in the water resistance of glue-bound papers by treatment with formaldehyde, comparisons were made of several water resistance test methods as well as of certain empirical tests commonly applied to coated papers. There appeared to be no fixed relationship between the results of testing coated papers by several different methods. The water resistance of glue-bound coated papers may be materially increased by either applying formaldehyde to the freshly coated paper or incorporating formaldehyde in the coating mixtures. With coating mixtures based on medium-grade glues the optimum viscosity and working life occurs at about 35° F. Under these conditions from 5 to 8 percent of formaldehyde, based on the weight of glue, may be added without harming the coating mixture.

The use of glue in the paper industry. G. K. Hamill. Pub. by the Glue Research Corp. (1928). OP.

A hand-book published by the Glue Research Corporation. It gives a summary of the information gathered during the investigation of the uses of glue in the paper industry by the National Association of Glue Manufacturers Fellowship at the Bureau of Standards. The publication contains an outline of papermaking processes in general, information on uses of glue in beater sizing, surface sizing and coating, and a bibliography of publications dealing with these subjects.

Further study of paper coating minerals and adhesives. M. B. Shaw, G. W. Bicking and M. J. O'Leary. BS J. Research 5, 1189 (1930).	RP254	10¢
--	-------	-----

In view of recent developments in paper coating materials, tests were made to determine the comparative value of casein, glue and modified starch as adhesives, and of domestic and foreign clays and a commercial compound of diatomaceous earth as minerals, for coating paper. Printing tests were made on the coated papers at the Government Print-

<u>Title</u>	<u>Series</u>	<u>Price</u>
ing Office by the half-tone process. The diatomaceous earth compound did not adhere well to the fiber sheet. The American clay that had been refined by present methods compared favorably with the foreign clays. Equally good results were obtained with the three different kinds of adhesives, although the starch-bound coatings may possibly have absorbed somewhat more ink in the printing.		

Commercial casein-relationship between laboratory tests and coating quality. E. O. Whittier, S. P. Gould, R. W. Bell, M. B. Shaw and G. W. Bicking. Ind. and Eng. Chem. 25, No. 8, 904 (August 1933).

The coating quality of commercial caseins differs considerably but the major differences cannot be related to the chemical composition or to the customarily determined physical properties of the caseins. Hydrochloric acid caseins and "self-sour" caseins yield coatings differing in smoothness and surface-sizing. Both poor and good caseins were found among samples made by each of the commonly used methods. Laboratory determinations and results of coating tests are given in detail on 13 commercial caseins and on 5 caseins made by different methods from the same lot of milk. The significance and limitations of tests on casein are discussed.

The colloidal nature and related properties of clays. W. W. Meyer. J. Research NBS <u>13</u> , 245 (1934).	RP706	OP
--	-------	----

A theory is presented on the colloidal nature and related properties of clays, based upon the findings of certain soil scientists and the existing knowledge of the phenomena of coagulation, deflocculation, plasticity, drying, shrinkage, and dry transverse strength. It is thought that this paper will allay some of the present confusion of ideas concerning the subject of clay colloids by adaptation of this theory to furnish a more satisfactory explanation of the above phenomena.

Suitability of sweet potato starch for the beater sizing of paper. C. G. Weber, M. B. Shaw and M. J. O'Leary. Misc. Pub. NBS, M150 (1935).	M150	5¢
--	------	----

This investigation was made to determine the value of starch made from cull sweet potatoes, by the Bureau of Chemistry and Soils, as beater sizing for paper. The sweet potato starch was appraised by comparison with representative commercial sizing starches, made from corn and cassava, in a series of book papers made in the Bureau of Standards mill. Test data on the papers indicate that it is a high-grade sizing starch.

<u>Title</u>	<u>Series</u>	<u>Price</u>
Effect of filling and sizing materials on stability of book papers. M. B. Shaw and M. J. O'Leary. J. Research NBS <u>21</u> , 671 (1938).	RP1149	10¢

Seventy-two experimental book papers were made in the Bureau's semi-commercial mill. Extensive physical and chemical test data with particular reference to stability are given for the papers. The fillers used were clay, titanium pigments, zinc sulfide pigments, and calcium carbonate; the sizing agent was rosin soap; the fibrous materials covered the range commonly used in the fine printing papers. The papers containing titanium, zinc sulfide, or precipitated calcium carbonate pigments had the highest opacity. The nonalkaline fillers had no apparent harmful influence on the stability of the papers, and the calcium carbonate had a protective or inhibiting effect in accelerated aging tests. Acidity was an important factor in deterioration. Attack on the cellulose was increased as the amount of alum was increased, in either the unsized or the rosin sized papers.

3. Manufacturing Processes

<u>Title</u>	<u>Series</u>	<u>Price</u>
Couching properties of wet felts. F. C. Clark and A. G. Durgin. Paper Industry <u>1</u> , No. 12, 1115 (March 1920). CP.		
Addition of 10 percent of cotton to felt does not materially alter its structure or properties. A little more steam was required to dry the sheets from the cotton-wool felt. This quantity was very small. Somewhat inferior in couching properties to the wool felt. An average of 6.8 percent less water was removed by the cotton-wool felt. It appears that there were less openings through the cotton-wool felt than through the all-wool felt.		
A study of the experimental manufacture of condenser paper. M. B. Shaw and G. W. Bicking. Paper Industry <u>5</u> , No. 2, 309 (May 1923).		
For the manufacture of power condensers a light weight paper approximating 0.005 inch in thickness is necessary. The requirements for this paper are that it must be free from pin holes and from conducting particles. Difficulty has been experienced in obtaining such paper since most of the commercial papers contain approximately 30 to 40 such particles per square foot. Satisfactory paper was produced in the Bureau paper mill. The chief requirement in manufacturing this paper, in addition to cleanliness, is the use of a stone or composition beater roll from which metallic particles will not chip off.		
Hydrogen ion concentration in the paper mill. M. B. Shaw. Paper Trade J. <u>81</u> , No. 10, 59 (Sept. 3, 1925).		
A discussion of the application of hydrogen ion concentration determinations to control of sizing and other paper-making processes. It is shown that such a method of control gives superior results in respect to both quality of paper produced and economy of material.		
A study of some factors influencing the strength and stability of experimental papers made from two different sulphite pulps. R. H. Rasch, M. B. Shaw and G. W. Bicking. BS J. Research <u>11</u> , 7 (1933).	RP574	5¢
A series of 43 experimental bond papers were made in study of the effect of beating treatment and sizing materials on their stability and strength. Excess alum in both beater and surface sizing adversely affected the stability of the papers, but the rosin used in beater sizing did not promote instability. Both glue and starch surface sizing had little		

<u>Title</u>	<u>Series</u>	<u>Price</u>
effect on the strength and stability of the papers. The papers made with the most favorable beating and sizing treatments had only a moderate degree of stability.		
Research on the production of currency paper in the Bureau of Standards experimental paper mill. M. B. Shaw and G. W. Bicking. Tech. Pap. BS <u>21</u> , 89 (1926-27).	T329	OP
Describes some results obtained in determining the durability factors of paper suitable for currency use, with a view to increasing the wearing qualities and thereby prolonging the life of paper money. The experimental papermaking tests were made on a semi-commercial scale under practical mill conditions. The papermaking fiber was obtained from new linen and cotton rags. Various proportions of these materials were tried but best results were obtained with a mixture of 75 percent linen and 25 percent cotton. Paper of satisfactory printing quality and more than double the strength of that being supplied for currency use was produced. The increase in strength was attributable chiefly to the very gradual application of beater-roll pressure and low concentration of beater furnish.		
Fiber building boards, their manufacture and use. C. G. Weber. Ind. and Eng. Chem. <u>27</u> , No. 8, 896 (August 1935).		
This paper was prepared at the request of the American Chemical Society for a Symposium on Building Materials at the 1935 Spring Meeting. It outlines the raw materials used, the methods of manufacture, and the properties and uses of the two principal types of fiber building boards, common wall boards and heat and sound insulating boards.		
Further experimental production of currency paper in the Bureau of Standards paper mill. M. B. Shaw and G. W. Bicking. BS J. Research <u>3</u> , 899 (1929).	RP121	15¢
The publication describes recent experimental tests to improve the durability of United States currency paper, and is supplementary to Tech. Paper No. 329, which reported the results obtained in earlier stages of the study. The subsequent work included the use of caustic soda as compared with lime for cooking the rags, the effect of variation in fiber composition, further study of the beating procedure, determination of optimum surface-sizing conditions for the best printing results, and comparative study of commercial manufacturing operations and Bureau practice. As a result of the investigation, the strength of currency paper has been		

<u>Title</u>	<u>Series</u>	<u>Price</u>
doubled, and paper of similar quality, superior in strength to any previously available, is being produced commercially. It is believed that the test data will be of value in the general technic of papermaking.		
Experimental production of roofing felts. M. B. Shaw, G. W. Bicking, and O. G. Strieter. BS J. Research <u>2</u> , 1001 (1929). Experimental felts were made with varying proportions of the usual fibrous materials and with a high content of low-grade substitutes such as waste papers and sawdust. The waterleaf felts were made in the semi-commercial paper mill of the Bureau but were saturated and coated, and thus converted into roofing, in a commercial roofing mill. The results indicate that relatively large amounts of the substitutes can be introduced into roofing felts without causing great difficulty in the manufacturing processes.	RP67	5¢
Odorous fumes from sulphate pulp mills. C. G. Weber. NBS Letter Circular LC508 (1937). The sulphate process of cooking wood for pulp involves the formation of gases and easily-volatile substances that are characterized by extremely offensive odors. The malodorous substances are heavier than air, and are obnoxious in extremely low concentrations; hence, if they are permitted to escape to the atmosphere the offending mill becomes a nuisance in the community. This article discusses briefly the nature of the malodorous substances, their formation in the process, and the steps necessary for the collection and destruction of the substances to minimize the escape of odors.	LC508	Free NBS
An experimental study of beater practice in the manufacture of offset papers. C. G. Weber, M. B. Shaw, M. N. Geib, and M. J. O'Leary. J. Research NBS <u>28</u> , No. 3, 241 (1942). The relationship between beater practice and the characteristics of wood-fiber offset lithographic papers was investigated in the semi-commercial mill of the paper section. The fibrous raw materials were pulps of the types commonly used in commercial papers. A series of papers was made from each of the fibrous materials and from mixtures of them. Each series comprised papers made with widely different degrees of beating, and the effects of the variations in degree of beating were determined by laboratory and printing tests of the papers.	RP1455	10¢



B. PROPERTIES AND TESTING OF PAPER

1. General

<u>Title</u>	<u>Series</u>	<u>Price</u>
Some observations on paper testing problems. F. T. Carson. Paper Trade J. <u>101</u> , No. 8 (August 22, 1935). The twofold scope of paper testing, mill control and consumer testing is outlined, and the opportunity for the extensions of standards in this field is pointed out. The nature of a laboratory test of paper demands that the test be well planned to represent faithfully the behavior with respect to the property in question. Attention is called to some unique features of paper and certain differences in the testing requirements of paper as compared to other materials.		
Preparation of fiber test sheets. M. B. Shaw, G. W. Bicking and L. W. Snyder. BS J. Research <u>5</u> , 105 (1930). A laboratory method developed at the Bureau for making small sheets of fibers for evaluating the papermaking qualities of pulp is described. The method relates to the forming of the sheet of fibers on the mold and the subsequent operations of couching, pressing, and drying. With the equipment and procedure described, the sheets are made of uniform quality--formation, weight--and can be duplicated as desired. The personal equation is reduced to a minimum and truly comparable results are obtained.	RP190	10¢



2. Chemical Properties

<u>Title</u>	<u>Series</u>	<u>Price</u>
The detection of animal size in surface sized papers. F. T. Carson. Paper Trade J. <u>78</u>, No. 15, 168 (April 10, 1924). The usual tannic acid test for detection of glue cannot be relied on as some starches give a similar reaction. Attention is called to a method of removing starches by hydrolysis before applying the test. A simpler method is described which consists of adding ammonium molybdate in slightly acid solution to an aqueous extract of the paper.		
An extractor and friction cleanser. F. T. Carson. Paper Trade J. <u>80</u>, No. 12, 53 (March 19, 1925). Apparatus designed to remove surface coatings from carbon paper and other similar papers is described. This is of service where it is desired to obtain the basic paper in good condition for testing or where quantitative determination of coating and impregnating materials is desired.		
A modified method for the determination of the copper number of paper. B. W. Scribner and W. R. Brode. Tech. Pap. BS <u>22</u>, 9 (1927-28). A modified method particularly adapted to determining the copper number of heavily sized rag-fiber bond paper is described. It is patterned after the method of Gault and Mukerji, and that of Staud and Gray. A variation from these methods considered of prime importance is grinding the test specimens to a finely divided condition. This was found essential for obtaining uniform and accurate test results, and such procedure shortens the time required for treatment of the paper in the various analytical manipulations.	T354	OP
The determination of alpha cellulose content and copper number of paper. J. O. Burton and R. H. Rasch. BS J. Research <u>6</u>, 603 (1931). Modifications of the methods for determining the alpha cellulose content and copper number of cellulosic materials were made and the methods adapted to paper analysis. The modification considered of prime importance is the reduction of the paper to a cotton-like form by means of a mechanical disintegration. This was found to be essential for accurate and uniform results. It is also very important to take into account the amounts of sizing and loading materials which the paper contains. The alpha cellulose method is patterned after that of Jentgen with modifications suggested by Parsons and Ross. The copper number method is that of Braidy with a few minor modifications.	RP295	10¢

<u>Title</u>	<u>Series</u>	<u>Price</u>
Simplified determination of resin in papers and pulps. H. F. Launer. J. Research NBS <u>18</u> , 227 (1937).	RP973	5¢
A method is given for the simple and precise determination of resin in papers, which have been surface-sized with glue or starch, coated with casein-clay emulsion, or not coated or surface-sized. The extracting solution is 95 percent ethyl alcohol acidified with hydrochloric acid. The extract is taken up in anhydrous ether, so that the usual laborious and time consuming washing of the ether solution with water to eliminate the nitrogenous sizing or coating materials is avoided. The method is applicable also to the determination of natural resins in wood pulps.		
Simplified volumetric determination of alpha, beta and gamma cellulose in pulps and papers. H. F. Launer. J. Research NBS <u>18</u> , 333 (1937).	RP979	5¢
A relatively rapid and simple method for determining alpha, beta and gamma cellulose is described. The procedure, which employs a 0.3-g sample, is entirely volumetric, involving no moisture or ash determinations or other precision weighings. The separation is based upon the most recently found facts concerning the equilibria involved. Additional information concerning the chemistry of pentosans and beta cellulose has been obtained.		
Simplified volumetric determination of alpha, beta, and gamma cellulose in pulps and in papers containing sizing, filler, and other materials. H. F. Launer. J. Research NBS <u>20</u> , 87 (1938).	RP1068	5¢

Data are presented which show that the volumetric method for determining alpha, beta and gamma cellulose, described in Research Paper RP979 of the National Bureau of Standards, is applicable to papers containing rosin, glue, and starch, and to pulps containing natural resins in any amount. Precise corrections for the sizing materials and the resin may be made, resulting in alpha cellulose values which are in good agreement with the results of a gravimetric procedure for a wide range of materials. It was found that papers containing lignin or any mineral fillers may be analyzed by the volumetric method in much less time than by the gravimetric procedure.

<u>Title</u>	<u>Series</u>	<u>Price</u>
Determination of pentosans in pulps and papers. H. F. Launer and W. K. Wilson. J. Research NBS <u>22</u>, No. 4, 471 (1939). A relatively rapid method for determining pentosans in pulps and papers is described. With a minor change, the simple and rapid method of distillation prescribed by the Association of Official Agricultural Chemists was retained, since a comparison, using a given paper, showed that various modifications of the method gave no higher values for pentosans. From a study of the rates of evolution of volatile material, it was concluded that volatile material arises from the cellulose in all of the usual fibrous materials used for papermaking during the pentosan distillation. On the basis of rate data, the value of the correction was found to be approximately 1.0, calculated as percent pentosan. It was further shown that the pentosan content of cotton materials is probably negligible.	RP1199	5¢
Determination of the pH value of papers. H. F. Launer. J. Research NBS <u>22</u>, No. 5, 553 (1939). A simplified procedure for determining the pH value of papers is described. The values obtained therewith are in good correlation with the amounts of alum used in the manufacture of the papers, and with the chemical stability of the papers. The requirement of present standard methods, that the pH of the water used in extraction should be in the range 6.6 to 7.0, or even 6.9 to 7.1, is probably unnecessary for papers which test from pH 4.0, or below, to pH 7.2. Distilled water containing sufficient CO₂ to give a pH as low as 5.9 is satisfactory for direct use in this range.	RP1205	5¢
Retention of aluminum ion and hydrogen ion in papers. H. F. Launer. J. Research NBS <u>23</u>, No. 6, 663 (1939). The decrease in pH, observed when paper-water mixtures are heated and then cooled, was found to be ascribable to the increased hydrolysis of the aluminum in the papers. Studies of fiber-alum-water mixtures showed that aluminum is retained by the fibers, and that the amount of aluminum in papers is thus much larger than that calculated solely from the concentrations involved in the manufacture of papers. It was found that the fibers raised the pH of alum solutions to which they have been added by an amount which is characteristic of the type of fiber and of the concentration of the alum. Hydrogen ion is also strongly retained by fibers in an amount shown to be unchanged after heating and cooling.	RP1262	5¢



3. Physical (Mechanical)

<u>Title</u>	<u>Series</u>	<u>Price</u>
A preliminary study of tearing instruments and tearing test methods for paper testing. P. L. Houston. Tech. Pap. BS, T194 (1921).	T194	OP
A study is made of the relative effect of different sizes of test samples on the tearing strength of the paper. Data are reported to show that the larger the test sample the greater are the values of tearing strength. The reason for this is brought out as fabric assistance, which is of considerable importance in the textile industry. Since better comparative results are obtained by tearing paper in the machine direction it would seem that all tearing tests should be made in this direction.		
Supplementary study of commercial instruments for determining the tearing strength of paper. P. L. Houston. Paper Trade J. <u>74</u> , No. 10, 43 (March 9, 1922). OP.		
Results of tests on the Elmendorf tester. This tester is built on sound principles of mechanics, is calibrated correctly, and will perform satisfactorily provided certain recommendations are made mandatory in order to control test results and prevent the serious variations that different operators are very apt to obtain by using different plies in testing the same papers.		
A study of commercial dial micrometers for measuring the thickness of paper. P. L. Houston and D. R. Miller. Tech. Pap. BS <u>17</u> , 125 (1922-24).	T226	10¢
This paper records a study of the mechanisms, calibrations, areas and parallelisms of contact surfaces and static contact pressures for different readings of nine commercial micrometers. A performance test is made on the nine instruments, and a new instrument is constructed to measure the compressibility of paper under different contact pressures and different size contacts. The results of the performance and compressibility tests show that different results may be expected from thickness tests on the same paper when different commercial micrometers are used because of their different contact pressures and different size contacts. In the conclusions, recommendations are made for the construction of a new standard micrometer.		
Effect of length and width of test specimens on the breaking strength and elongation of paper. P. L. Houston. Paper Trade J. <u>76</u> , No. 12, 54 (March 22, 1923). OP.		

Title

Series Price

There are a number of devices for determining the breaking strength and elongation of paper, but there is little uniformity in the procedure as to width and length of the test strip, the rate of applying the load and the time during which the specimen is under stress. A study of these various factors indicates that there is a considerable difference in the amount of stretch when the factors are varied, but that, when only the strength is to be considered, the length of the specimen, within certain limits, is negligible and that the strength is almost proportional to the width.

A quick test to determine the brittleness of paper. P. L. Houston. Paper Trade J. 76, No. 15, 233 (April 12, 1923). OP.

By means of two steel rollers, a crease is made under controlled conditions of pressure and time and the bursting strength is determined before and after such folding. The loss in strength under such conditions is an excellent indication of the brittleness of the paper. The grading of paper by this method is practically the same as that obtained by the Schopper folding endurance tester.

An analysis of the strength of paper. F. T. Carson. Paper Trade J. 78, No. 12, 51 (March 20, 1924).

A discussion of the causes of the apparent anomalies in paper testing shown in a previous publication (The effect of atmospheric humidity in the physical testing of paper). The strength of paper is attributed to the net effect of two independent factors, the strength and flexibility of the fibers and the mutual adherence of the fibers. Both of these factors are affected by the changes in moisture content caused by variations in atmospheric humidity. The resulting effects on the different physical tests are discussed.

Effect of weight of needle of Mullen paper tester on the bursting strength test. R. E. Lofton and C. J. Costello. Paper Trade J. 78, No. 20, 58 (May 15, 1924).

Tests were made of a variety of papers, using three gage needles of different weights. The results obtained with the different needles agreed closely, showing that the weight of the needle does not influence the bursting test values.

A wet rub tester for paper. F. T. Carson and F. V. Worthington. Paper Trade J. 84, No. 2, 45 (Jan. 13, 1927).

In connection with the research made to improve the quality of U. S. paper currency it was found necessary to test the resistance of the paper to abrasion. The measurement of

TitleSeries Price

this property is of importance in the case of most surface-treated paper. This publication describes a motor driven testing device which consists of a means of clamping the specimen firmly over a smooth surface, a weighted friction surface, an automatic counter and an automatic means of stopping the motor when a hole is rubbed through the specimen. Data are also given showing the nature of the results obtained.

Calibration and adjustment of the Schopper folding tester. F. T. Carson and L. W. Snyder. Tech. Pap. BS 22, 125 (1927-28). T357 10¢

The results obtained with the Schopper paper folding tester are affected to a considerable extent by relatively small errors in the adjustment of the working parts and by friction in these parts. Since most of these errors are equivalent to errors in adjusting the tension of the specimen it is necessary to calibrate the tester frequently and re-adjust if necessary the tension of the clamp springs. An improved device, which is essentially a balanced bell-crank lever, is described which greatly facilitates the calibration.

Increasing the capacity of the Elmendorf tearing tester. F. T. Carson and L. W. Snyder. Paper Trade J. 36, No. 13, 57 (March 29, 1928).

In order to make the Elmendorf tearing tester suitable for testing heavy fibrous materials, such as roofing felts, an auxiliary weight was designed so that it could be quickly attached to the tester and used without any other alteration in the instrument, the same scale being used either with or without the augmenting attachment. To do this it was necessary to derive an adequate calibration formula for the tester and then to set up an analogous one for the heavy-duty tester. The calibration procedure is given in some detail and a simple procedure for periodic adjustment is outlined. Some improvements are also suggested.

A study of the Thwing impact tester. H. C. Eckhardt and L. W. Snyder. Paper Trade J. 36, No. 15, 64 (April 12, 1928).

This paper presents the results of a study of the Thwing impact tester to determine its suitability for testing heavy paper and paper boards. This device appears to be capable of giving consistent results when used for testing paper boards, but the range of the instrument is not well suited to the testing of ordinary papers. A comparison is made with the hydraulic type of bursting strength tester and a fair degree of agreement with this type of tester is found. A method of calibrating the instrument is outlined.

<u>Title</u>	<u>Series</u>	<u>Price</u>
Results with testers for measuring tensile strength of paper. R. E. Lofton and L. W. Snyder. Paper Trade J. <u>36</u> , No. 24, 63 (June 14, 1928).		
This paper gives the results of tensile strength tests as obtained with six commercial testers of various types. A description of each instrument and the method used in calibrating it are given. Seven different samples of paper, ranging in tensile strength from about six to thirty pounds, were used in this investigation. Tests were made under standard atmospheric conditions - 65 percent relative humidity and 70 degrees Fahrenheit temperature. A total of 1680 test specimens was used.		
Most of the testers gave fairly uniform results, although there are a few cases of abnormally large variations.		
Critical study of methods of measuring the bulk of paper. F. T. Carson. BS J. Research <u>2</u> , 1039 (1929).	RP69	10¢
A study has been made of the means of measuring the property of paper known as bulk. The factors influencing bulk tests made with the thickness gage and the pressure bulker were investigated. It was found that the amount of pressure used is the chief factor. Conditions were found for bringing the different types of instruments into substantial agreement and a standard procedure was recommended.		
Care and adjustment of folding testers of the Schopper type. F. T. Carson and F. V. Worthington. Cir. BS, C379 (1929).	C379	5¢
Testers of the Schopper type for measuring the folding endurance of paper require considerable attention, since the folding results may be affected by relatively small changes in adjustment. Poor alignment of the rollers, between which the paper is folded, or excessive friction in these rollers may produce serious error in the folding results. The bell-crank lever device for adjusting the spring tension, which was described in a previous publication, has been adapted to the measurement of the friction of the rollers, and this procedure is here described. A procedure is outlined for the periodic inspection and adjustment of folding testers of the Schopper type.		
Directional designation in physical tests of paper. F. T. Carson and L. W. Snyder. Paper Trade J. <u>21</u> , No. 12, 65, (Sept. 18, 1930). OP.		
A chart was prepared which shows how paper test strips should be cut relative to designation of the two principal directions of the paper in reporting test results, and how to		

<u>Title</u>	<u>Series</u>	<u>Price</u>
obtain a maximum of the different kinds of tests from a limited sample. In addition to explanation of the chart, a discussion of the subject is given.		
Critical study of the bursting strength test of paper. F. T. Carson and F. V. Worthington.	RP278	10¢
BS J. Research <u>6</u> , 339 (1931).		
Possible causes and alleged causes of inconsistent results in the bursting strength test for paper were investigated. The study included clamping pressure, clamping surfaces, size of bursting orifice, diaphragms, pressure gauges and speed of operation. Some were found to be without measurable effect, while others were found to affect the results more or less seriously. Recommendations are made for adequate clamping pressure and for the nature of the clamping surfaces and the size of the bursting orifice. Tensile and bursting data are correlated with the aid of a well-known engineering formula.		
New types of equipment for testing paper. F. T. Carson and F. V. Worthington. Paper Trade J. <u>95</u> , No. 16, 34 (Oct. 20, 1932).		
Three paper testing devices are described. (a) A float in which the specimen is clamped under a cover glass is used in making the dry indicator test for water resistance. (b) An inclined pipette mounted on a frame and provided with a needle valve is used to deliver a very small measured drop of water onto the surface of paper in making an absorption test. (c) An extraction apparatus which combines the reflux condenser with light scrubbing is used to clean a large sheet of processed paper for the purpose of inspecting or testing it.		
A study of the M.I.T. paper folding tester. L. W. Snyder and F. T. Carson. Paper Trade J. <u>96</u> , No. 22, 40 (June 1, 1933).		
Measurements were made of important characteristics of a number of M.I.T. folding testers, such as variation in tension, curvature of the folding surfaces, and rate of folding. Performance tests were then made on a number of samples of paper. Some correlation was found between the variation in individual tests of paper and the measured machine variables, although the relations were not altogether conclusive. Tests were also made on the M.I.T. and Schopper folding testers. There was no correlation between the two sets of results. A proposed testing method involving the use of the M.I.T. folding tester was outlined.		

<u>Title</u>	<u>Series</u>	<u>Price</u>
Maintenance, calibration, and use of paper testing instruments. F. T. Carson. Paper Industry <u>16</u> , No. 9, 621 (Dec. 1934).		
This paper is a popular discussion of the chief points in the maintenance, calibration, and operation of common paper testing instruments. The instruments discussed are the psychrometer for measuring the hygrometric condition, the ream weight balance, the dial micrometer for measuring thickness, the tensile strength tester, the bursting tester, the tearing tester, and the folding endurance tester. Those phases of maintenance and calibration that can readily be attended to in any paper testing laboratory, especially those of importance most likely to be neglected, are emphasized.		
Some observations on determining the size of pores in paper. F. T. Carson. J. Research NBS <u>24</u> , No. 4, 435 (1940).	RP1292	5¢
Methods hitherto used in determining the size of pores in paper depend on the rate of efflux of fluids; the rate of rise of liquids in vertical strips; or the capillary pressure. A new method is described, which takes advantage of the fact that the coefficient of slip of air in viscous flow through paper is a function of pressure. From the Meyer equation the average effective pore radius is evaluated in terms of the air-permeability values at two different pressures. The experimental values for two such air-permeability determinations for each of five papers, and the resulting values calculated for average effective pore radius, are tabulated.		
Simplified curl tester for paper. F. T. Carson and V. Worthington. The Paper Industry <u>22</u> , No. 3, 246 (June 1940).		
The tendency of paper to curl, which is important in printing operations and in other industrial uses of paper, has for some time been measured in an approximate manner by means of the curl sizing tester. A simplified apparatus was recently made in connection with the development of a Federal specification for tabulating cards. The construction and use of this testing device are described.		
Evaluating the wearing quality of currency paper. F. T. Carson and V. Worthington. J. Research NBS <u>26</u> , 467 (June 1941).	RP1390	10¢
This report describes means which have been developed to determine the relative serviceability of currency-type papers. A reproducible crumpling and smoothing cycle has been developed with which to imitate the appearance and characteristics of worn paper currency. The changes in significant		

TitleSeries Price

physical properties of this worn paper are then measured. An automatic, motor-driven crumpling apparatus is used, which alternately crumples and straightens out a specimen at a rate of about seven times per minute. The change in air permeability as the crumpling procedure progresses appears to be the most useful single measure thus far found of the decreasing serviceability of the paper. An air permeameter, specially designed for use in conjunction with the crumpling apparatus, is briefly described.

Testing the adhesive strength of gummed paper sealing tape.

C. G. Weber. Modern Packaging 15, No. 4, 66 (Dec. 1941).

This paper describes for the nontechnical reader an adhesion test for gummed sealing tape. The apparatus and its operation are explained, and necessary control is pointed out. Some data on the reproducibility of the test results are included.



2. Microscopic Examination

<u>Title</u>	<u>Series</u>	<u>Price</u>
Method of differentiating and estimating unbleached sulphite and sulphate pulps in paper. R. E. Lofton and M. F. Merritt. Tech. Pap. BS, T189 (1921). Contains a review of methods that have been proposed for differentiating between unbleached sulphite and sulphate pulps and gives the procedure followed in developing a new and comparatively rapid method. The method of preparing the new stain and the method of procedure for differentiating between unbleached sulphite and sulphate fibers is described in detail. Tables are given showing the results of quantitative microscopical analysis of mixtures of these fibers stained by the new method.	T189	OP
The photomicrography of paper fibers. R. E. Lofton. Tech. Pap. BS 16, 629 (1921-22). This paper reports an investigation of the efficiency of the incandescent light as a source of illumination in photomicrography, of the value of light filters, of the proper use of the substage condenser and diaphragm, of the advantages of a long bellows extension, and different types of photographic plates. A bibliography on photomicrography and related subjects is given.	T217	5¢
Improvements in methods of making the Herzberg stain used in fiber analysis. M. F. Merritt. Paper Trade J. 75, No. 8, 43 (August 24, 1922). OP. In using the Herzberg stain for identifying fibers, it is essential that extreme care be taken in its preparation. Variations in method of preparation that may cause poor results are cited and recommendations are given as regards procedure for the best results.		
Preservation of standard fiber samples. M. F. Merritt. Paper Trade J. 78, No. 1, 52 (Jan. 3, 1924). An investigation was made of the manner of preserving standard fiber samples used for reference in estimating the fiber composition of paper. Samples that had been kept for several years both in the dry state and in water were tested with the stains commonly used in order to find if the correct color reactions were obtained. The results show that samples may be kept indefinitely in the dry state but that if kept in water they should be renewed at least every two years.		

<u>Title</u>	<u>Series</u>	<u>Price</u>
Pulp and paper fiber composition standards. M. F. Merritt. Tech. Pap. BS <u>18</u> , 101 (1924-25).	T250	15¢

Contains illustrations of common papermaking fibers and fiber mixtures, showing the color reactions with various stains for use as reference standards in identification and estimation of fiber composition of paper. Details are included regarding the preparation of the stains used, the water colors used to reproduce the colors of the stained fibers and the method of drawing the fibers.

Determination of the fiber composition of roofing felts.

R. E. Lofton. Paper Trade J. 84, No. 18, 57 (April 7, 1927).

Describes method used and gives results obtained in fiber determinations on six roofing felts made in the Bureau's paper mill. Fiber determinations were made by the "dot-count" method. By this method, the slide is placed on the mechanical stage of the microscope, moved across the field of view, and each fiber or portion of fiber is counted as it passes under a point on the diaphragm of the eyepiece. This method eliminates errors due to estimating lengths and sizes of fibers. The results obtained by the different analysts agree very closely and indicate that a comparatively inexperienced analyst can, by use of the dot-count method, arrive at as nearly correct determinations of the fiber composition as could be arrived at by calculations based upon the mill weights of the different constituents.

5. Optical Examination

<u>Title</u>	<u>Series</u>	<u>Price</u>
Specifications of the transparency of paper and tracing cloth. Cir. BS, C63 (1917). Transparency is specified by measuring the contrast ratio, B/W, where B and W are the brightnesses resulting when the material is placed over black and white (MgO) surfaces, respectively.	C63	5¢

A measure of the color characteristics of white paper. R. E. Lofton. Tech. Pap. BS <u>17</u> , 667 (1922-24).	T244	5¢
---	------	----

Since the color differences between white papers are usually relatively small, it is obvious that a method capable of giving a measure of these differences must be quite sensitive to very small color increments, and that a method which makes use of the principle of multiple reflections will be much more sensitive to small color differences than any method which makes use of a single reflection. The principle of multiple reflections is employed in the Pfund colorimeter, which colorimeter was used to measure the color characteristics of 21 commercial papers.

The color characteristics of each paper were determined by finding the coefficients of diffuse reflection for red (wave length 625 mu), green (wave length 550 mu), and blue (wave length 460 mu) light. It was found that none of the papers tested was truly white, but that each was more or less deficient in blue and less so in green.

The glarimeter and the measurement of the finish of paper. R. E. Lofton. Paper Trade J. 80, No. 7, 47 (Feb. 12, 1925); No. 16, 58 (April 16, 1925).

Results are given of a study of the application of the Ingersoll Glarimeter to measurement of degree of finish of paper. It is concluded that the instrument is suitable for this purpose. The method of calibrating the instrument and the procedure to follow in using it are described.

Sources of error in measuring opacity of paper by the contrast-ratio method. D. B. Judd. BS J. Research <u>12</u> , 345 (1934).	RP660	5¢
--	-------	----

Contrast ratio of a paper sample is defined as the brightness of the illuminated sample when backed by a black-lined cavity, divided by its brightness when backed by a surface of magnesium oxide. In practice other less fragile surfaces are substituted for the MgO surface, and to protect these substitute surfaces as well as the paper samples them-

<u>Title</u>	<u>Series</u>	<u>Price</u>
selves the samples are kept from touching the surfaces. Both departures from the definition are potential sources of error. These errors have been investigated experimentally and a theoretical expression representing them is given.		
Reflective and transmissive properties of diffusing media. H. J. McNicholas. J. Research NBS <u>13</u>, 211 (1934). Many problems in the textile, paper, paint, ceramic, and other industries call for optical methods in the evaluation of various properties of raw materials, intermediate, and finished products. Among such properties are the color, gloss, and surface texture of fabrics, papers, and painted or enameled surfaces, the covering and tinting powers of paints and ceramic bodies, the transparency or optical density of printing papers, tracing papers, or photographic films, and the general diffusive properties of illuminating glassware and various reflecting surfaces. To obtain fundamental data which may serve as a rational basis for the development of suitable methods and instruments for these special purposes, equipment has been designed and constructed with which a complete determination of the diffusive and absorptive properties of various materials may be made. Applications of the equipment to specific problems are not included in the scope of this paper.	RP704	5¢
Opacity standards. D. B. Judd. J. Research NBS <u>13</u>, 281 (1934). Opacity of paper is commonly specified by the contrast-ratio method. According to this method the reflectance of the material backed by a perfectly absorbing surface, divided by its reflectance when backed by a highly reflecting material such as magnesium oxide is taken as an index of opacity. Magnesium oxide, itself, is, however, commonly not used as the white backing because of its fragility; nor is the white backing placed in actual contact with the sample. Because of these and other sources of error, opacimeters frequently give erroneous results. Standards of opacity made of permanent material serve to check and to calibrate such instruments. Such standards made of opal glass are described, the theory of their application is given, and results of tests by their use reported. It is found that TAPPI opacity corresponds to a reflectance of white backing in contact with the sample of about 0.89.	RP709	5¢
Standards for checking opacity meters. D. B. Judd. Letter Circular NBS, LC418 (1934).	LC418	Free NBS

TitleSeries Price

To provide a means of checking the adjustment of opacity meters of the type described in BS Circular C63, to discover whether they are reading according to the TAPPI definition, opacity standards of opal glass have been developed. These standards are 5 x 20 cm rectangles, 1.5 mm thick; they have been found to be permanent and cleanable. The opacities of the standards have been determined according to the official TAPPI method; they fall between 0.80 and 0.90. If any opacity meter fails to yield the given value of opacity, then it is not reading correctly and requires adjustment or calibration.

A standard may be purchased for \$15.00; or, it may be borrowed for one week free of charge.

A method for determining whiteness of paper. D. B. Judd.

Paper Trade J. 100, No. 21, 266 (May 23, 1935); also Tech. Assoc. Papers, Series XVIII, 392 (1935).

The method suggested is an extension of MacAdam's work on yellowish white textiles. It makes use of a color diagram on which equal distances in any direction refer to equally perceptible color differences. This color diagram is a transformation of the standard 1931 ICI coordinate system of colorimetry; the colors of the paper samples may be located on this diagram by any fundamental method of colorimetry using the ICI method. There remains yet to be discovered whether graders of paper use essentially the criteria used by MacAdam's observers; but preliminary results indicate that they do.

The dependence of reflectance and opacity on thickness; relation between contrast ratio and printing quality. D. B. Judd. Tech. Assoc. Papers, Series XVIII, No. 1, 441 (1935).

Two families of graphs were prepared from the Kubelka-and-Munk formula. The ordinate is reflectance for black backing; the abscissa is contrast ratio for a white backing of 89 percent reflectance; this is the contrast ratio found by the official TAPPI method for measuring opacity of paper. Each curve of the first family refers to different thicknesses of the same material characterized by its reflectivity; it shows the increase in opacity and in reflectance as thickness is increased.

Reflection measurements on pulp and paper. R. S. Hunter.

Paper Trade J. 100, No. 26 (June 27, 1935).

The gloss, brightness, opacity, lightness, color, and surface texture of pulp and paper are associated with the reflection of light. It is the object of this paper to explain these factors as they are evaluated by visual observation and inspection and as they are evaluated by physical measurements of reflected light.

<u>Title</u>	<u>Series</u>	<u>Price</u>
A gloss comparator and a study of different types of gloss effects. R. S. Hunter. Nat. Paint, Varnish & Lacquer Assoc. Cir. 493 (1935). The article presents an analysis of the gloss problem and lists all of the appearance characteristics which are associated with gloss. A new gloss comparator which measures and gives photographic records of some characteristics of gloss is described.		
A method for determining whiteness of paper, II. D. B. Judd. Paper Trade J., Tech. Sec. 103, 154 (1936); also Tech. Assoc. Papers, Series XIX, 359 (1936). The method previously proposed is found to be valid for about one-third of the 15 observers tested. Another group grades according to a standard of whiteness which is greenish-yellow relative to magnesium oxide; this type of grading has also been formulated, and the standard is called "natural paper white". The small remaining group grades by methods which have not been accurately formulated, but which appear to be intermediate between the other two.		
Optical specification of light-scattering materials. D. B. Judd. J. Research NBS 19, 287 (1937). In 1931 Kubelka and Munk worked out the relationship between reflectance and thickness of material for thin, homogeneous layers illuminated diffusely. In the equation expressing this relationship, the hypothetical ideal material is defined by two constants, reflectivity and coefficient of scatter. In this paper are given data demonstrating how well several types of paper can be specified by these constants. Summaries of results on vitreous enamel, dental silicate cements, and cold-water paints are given also.	RP1026	10¢
Publications on colorimetry and spectrophotometry. K. S. Gibson. Letter Circular NBS, LC398 (1939). This is a list of publications on colorimetry, spectrophotometry, and related subjects by members of the staff of the National Bureau of Standards.	LC398	Free NBS
Preparation and colorimetric properties of a magnesium-oxide reflectance standard. Letter Circular NBS, LC547 (1939). The smoke from magnesium freely burning in air deposited on a satisfactory base forms a uniform, fine-grained diffusing surface of high reflectance. By observing a few simple precautions, this surface of magnesium oxide (MgO) may be made reproducible; hence, it serves as a convenient and reliable standard.	LC547	Free NBS

<u>Title</u>	<u>Series</u>	<u>Price</u>
A multipurpose photoelectric reflectometer. R. S. Hunter. J. Research NBS <u>25</u>, No. 5, 581 (Nov. 1940); also published in J. Optical Soc. Am. <u>30</u>, 536 (1940). A condensed description also published in Paper Trade J. <u>113</u>, No. 22, 133 (Nov. 27, 1941). This is a null-type instrument designed to measure (45°, 0°) apparent reflectance, specular gloss, and approximate trichromatic coefficients. The selection of photocells, the choice of design, the calibration, the elimination of errors, and many of the applications of the instrument are described.	RP1345	10¢
Apparatus for the study of the photochemistry of sheet materials. H. F. Launer. J. Research NBS <u>24</u>, No. 5, 567 (May 1940). Destructively high temperatures are shown to be attained by sheet materials under usual conditions of irradiation by the electric arc, such as in "weathering" and "light" stability tests. Thus, temperatures must be controlled if light effects, as contrasted with heat effects, are to be observed. An apparatus is described for the close control of the temperature during irradiation of sheet materials, such as paper, cellulose acetate, rubber, etc., by bringing them into intimate contact with a thermostated metal backing by means of air pressure, and by removal of most of the infrared radiation. Arrangements are described for controlling the moisture and oxygen content, from normal to very low values, of the atmosphere around the samples during irradiation. Data are given showing the effectiveness of the various parts of the apparatus.	RP1300	10¢
Systematic color designations for paper. D. B. Judd. Paper Trade J., Tech. Sec. <u>111</u>, 201 (1940). Possible uses of systematic color designations such as described in a previous publication are discussed, and the studies required before adoption of such designations are suggested.		
Introductory dialogue (for a symposium on spectrophotometry in the pulp and paper industries). D. B. Judd and L. C. Lewis. Tech. Assoc. Papers <u>23</u>, 473 (1940); also published in Paper Trade J., Tech. Sec. <u>111</u>, 133 (1940). The dialogue is between Mr. Papermaker, a practical color man, and Mr. Meter, a specialist in color measurement by instruments. It brings out the color problems of paper-making and shows how instruments may be used either to supplement or to supplant direct visual examination.		

<u>Title</u>	<u>Series</u>	<u>Price</u>
Reflection-transmission relationships in sheet materials. H. F. Launer. J. Research NBS 27, No. 5, 429 (Nov. 1941); also J. Opt. Soc. Am. 32, No. 2, 84 (Feb. 1942).	RP1430	5¢

It was found that values for reflectance of transmissive sheets, diffusing or clear, calculated from transmissions of one and two sheets, agree well with the directly measured reflectances over a wide range of values and wavelengths, for materials such as paper, glass, and an organic plastic. The expression used as a basis for calculations,

$$R_a = \sqrt{1 - \frac{T_a^2}{T_{2a}}}, \text{ in which } R_a \text{ is the reflectance, and } T_a \text{ and}$$

T_{2a} are the transmissions of one and two sheets of a , respectively, was derived by considering the infinite series of reflections undergone by light in passing through two sheets. The role of the spectral and geometric distribution of the light, and the effect of fluorescence on the simple theory, are analyzed. The effect of varying the angle of incidence upon transmission and reflectance values is discussed.

6. Resistance to Liquids and Gases

<u>Title</u>	<u>Series</u>	<u>Price</u>
The testing of blotting paper. P. L. Houston and R. H. Ledig. Paper Trade J. <u>73</u> , No. 19, 88 (Nov. 10, 1921). OP.		
Blotting papers were tested by the Klemm strip test for absorbency by running 1 cc. of distilled water and of ink from a pipette, by the flotation test, and by practical blotting tests. The results indicate that an ash test with consideration of the rag content of the paper is a satisfactory means of determining the quality and is far better than any absorbency test.		
The determination of sizing quality. F. T. Carson. Paper Trade J. <u>74</u> , No. 14, 43 (April 6, 1922).		
A resume is made of test methods in common use and data given showing lack of agreement among the methods. O'Kell's electrolytic method is discussed at length, a relation for the resistance within the sheet being derived and a method indicated for conversion of data to a sheet of common thickness. A new test method depending upon the curling of paper when placed upon water is described.		
The determination of sizing quality. A supplementary report on the investigation of the electrolytic method. F. T. Carson. Paper Trade J. <u>75</u> , No. 10, 44 (Sept. 7, 1922). OP.		
Report of additional experimentation regarding the O'Kell electrolytic method. No definite relation was found between the data curve and the rate of absorption; therefore, it was found impossible to give a satisfactory interpretation to the curve as a whole. It is concluded that despite the strong appeal made by the very positive nature of the data obtainable the method must be considered of doubtful value.		
Testing waterproof paper. F. T. Carson. Paper Trade J. <u>79</u> , No. 10, 43 (Sept. 4, 1924). OP.		
A new method for testing papers having a high degree of moisture resistance is described. This is designated as the "Ground Glass" method. The paper to be tested is folded box-shape and filled with water after being placed on a piece of ground glass lying on a dark surface. On lifting the box, if the water has gone through, a film of moisture is seen, showing dark in contrast to the ground surface.		
A new sizing tester for paper. F. T. Carson. Paper Trade J. <u>79</u> , No. 17, 44 (Oct. 23, 1924).		

<u>Title</u>	<u>Series</u>	<u>Price</u>
An instrument is described for applying the "Curl" method of testing paper for degree of sizing. This method has been described in previous publications. Some of the chief features of the new instrument are: Means of determining more accurately the time interval of curling; means of temperature control; means of producing automatic and synchronous operations.		
Testing paper for permeability to liquids. F. T. Carson. Paper Trade J. <u>80</u>, No. 10, 59 (March 5, 1925). OP.		
A general discussion of the testing of paper for permeability to liquids, followed by a description of such testing methods developed by the Bureau. These include: A dye-sugar indicator method for degree of sizing; the use of ground glass as a detector of moisture; an absorption test; and a method of testing impermeability to organic liquids.		
Measurement of the degree of sizing of paper. F. T. Carson. Tech. Pap. BS <u>20</u>, 703 (1925-26).	T326	OP
Existing methods for testing the degree of sizing of paper (35 in number) are described, critically discussed, and experimentally compared. Stress is laid on the essential difference between the degree of internal sizing of paper and the degree of surface sizing. The lack of concordance of the various methods has been traced to the influence of selective absorption from solution and of an extraneous resistivity. A test of the rate at which water penetrates into paper is considered the most logical and useful test of the degree of internal sizing of paper. This was confirmed by the results of tests using methods of this type developed at the Bureau of Standards compared with the other sizing tests most used.		
A sensitive instrument for measuring the air permeability of paper and other sheet materials. F. T. Carson. BS J. Research <u>12</u>, 567 (1934).	RP681	OP
The instrument is designed to eliminate edge leakage into the test cell. An annular guard cell surrounds the test cell, and the lateral pressure gradient at the boundary of the test cell is eliminated. A specially designed pressure regulator maintains a very steady pressure drop across the instrument. The air flow is measured by a capillary flow meter. The total range of the instrument is about a millionfold. Materials half an inch thick can be tested, and it is not necessary to cut the specimen. Results are reproducible to a few tenths of one percent.		

<u>Title</u>	<u>Series</u>	<u>Price</u>
Effect of experimental conditions on the measurement of air permeability of paper. F. T. Carson. BSJ. Research 12, 537 (1934). Experimental results show that with few exceptions the flow of air through paper is proportional to the pressure difference, to the time of flow, to the effective area, and inversely proportional to the thickness. With the type of measuring instrument used the results do not depend upon the viscosity of the air. The effect of relative humidity is unpredictable. Air permeability of paper was found to increase somewhat with decreasing absolute pressure. All the data agree remarkably well with the Meyer equation and indicate that the air passages in paper behave as if they were long capillary tubes.	RP682	5¢
Testing the water resistance of paper and fiber board. F. T. Carson. Paper Trade J. 98, No. 21, 36 (May 24, 1934). An attempt is made to clarify in some degree the province of water resistance tests, and developments in the technique of applying the dry-indicator test to the whole range of papers and fiber boards are described. The properties ordinarily referred to as water resistance and moisture resistance are distinguished by the phase that enters the sheet. A simple method for applying the dry-indicator test to all types of papers and fiber boards, and some simple pieces of apparatus, are described. Some suggestions are also made toward fixing the end point more definitely.		
Permeability of membranes to water vapor with special reference to packaging materials. F. T. Carson. Misc. Pub. NBS, M127 (1937). A study of the data from about 30 sources in the literature shows that measurements of the permeability of membranes to water vapor have been made by four types of methods, with many modifications, and that the testing conditions have varied widely. Considerable variety was also found in units of expressing the results, data having been reported in at least 20 units. Sheet materials used in packaging range in permeability from that of waxes and rubber to that of textile fabrics. The data indicate that the transpiration of moisture is proportional to the area, to the time in the steady-state region, and, within certain limits, to the difference in vapor pressure. Temperature requires close control. Relative humidity and the slowness of diffusion of water vapor through air have a marked influence in some cases. Suggested mechanisms of moisture transpiration include consideration of gaseous diffusion, diffusion of moisture in solid solution, movement of moisture as a function of the content of hygroscopic moisture, and migration of absorbed water along surfaces.	M127	5¢

<u>Title</u>	<u>Series</u>	<u>Price</u>
A microburette for testing the absorptiveness of thin paper. F. T. Carson. J. Research NBS <u>18</u> , <u>41</u> (1937).	RP959	5¢

A microburette, designed to measure and deliver a hundredth milliliter of liquid, is described and illustrated. It consists of a capillary tube, with a sliding index, mounted so that the capillary can be adjusted to any necessary angle of inclination such that the column of liquid in the capillary advances the length of the slider, and thereby displaces a measured volume which then hangs as a small drop from the discharge tip. A mechanism is provided for transferring the pendant drop to the specimen. Although designed particularly for use in the testing of thin absorbent paper, the microburette can probably be adapted to other uses requiring the accurate dispensing of small amounts of liquids.

Notes on attaching a membrane to a water-vapor-permeability cell. F. T. Carson. Paper Trade J. 107, No. 18, 59 (Nov. 3, 1938).

A simple and effective method is suggested of attaching a specimen to a dish or permeability cell in preparation for a test of permeability to water vapor. The specimen is supported in the mouth of a Petri dish, or other cell, while the circular edge is molded in wax which makes a moisture-tight joint between the specimen and the cell. A template is used to fix the testing area. The specimen can be sealed in any desired height in the cell, and the seal is made with the cell in the upright position.

7. Hygrometry in Paper Testing

TitleSeries Price

The effect of atmospheric humidity on the physical testing of paper. P. L. Houston, F. T. Carson and R. S. Kirkwood. Paper Trade J. 76, No. 15, 237 (April 12, 1923). OP.

The results of an extended investigation into the effect of humidity changes on the physical properties of paper are presented. Data and extracts from the literature are cited to indicate that the physical qualities are determined by relative humidity rather than by absolute humidity. The data are presented as graphs of the percent variations from values at 65 percent relative humidity, since this condition is used almost universally in the industries. Eleven grades of paper were tested for nine physical properties at eight relative humidities varying from 15 percent to 83 percent. A description of the method of procedure for each test is given and is accompanied by a discussion of results. It is shown that folding endurance, elongation and tearing resistance increase considerably with relative humidity over the observed range; tensile breaking strength and bursting strength increase up to about 40 percent relative humidity and then decrease; the increase with humidity of moisture content, ream weight, and thickness is relatively small, and the percent change of dimensions of the sheet is smaller still.

A small constant humidity testing cabinet. F. T. Carson.

Paper Trade J. 82, No. 8, 231 (Feb. 25, 1926). OP.

Paper is hygroscopic and as its physical properties are considerably affected by its moisture content, strength tests and other physical tests must be made under definite hygrometric conditions. As apparatus for maintaining these conditions in the usual laboratory testing room is quite expensive, most of the industrial laboratories lack such equipment. To assist in remedying this situation, an inexpensive air-conditioned testing cabinet has been developed. The testing instrument is placed inside the cabinet, and the test specimens are handled by means of long-sleeved rubber gloves fastened to apertures in the cabinet, thus obviating the necessity for exposing the interior of the cabinet to the surrounding atmosphere. A constant relative humidity is maintained in the cabinet by circulating the air through a solution of sulphuric acid, the relative vapor pressure of which is determined by its density.

Control of relative humidity in a small inclosed space. F. T. Carson. Paper Trade J. 93, No. 18, 71 (Oct. 29, 1931).

In response to a demand for information about maintaining constant humidity in a small space, especially in a small

<u>Title</u>	<u>Series</u>	<u>Price</u>
cabinet in which some testing of paper can be done, a brief description is given of suitable apparatus, together with a compilation of data for the preparation of solutions having the required relative vapor pressure. Data are given for sulphuric acid solutions, glycerine solutions, and saturated solutions of certain salts. The effects of temperature variation, the control of temperature, and the measurement of humidity are discussed.		

Hygrometry in paper testing. F. T. Carson and F. V. Worthington. Paper Trade J. 94, No. 2, 34 (Jan. 14, 1932).

Many of the properties of paper are influenced to a considerable extent by the content of hygroscopic moisture. This moisture content is determined largely by the relative humidity of the surrounding atmosphere, and, therefore, it is most convenient to express hygrometric data in terms of relative humidity. The various hygrometric methods are briefly discussed and described with reference to their suitability for use in the paper testing laboratory. Of the four types of methods, analytical method, dew-point method, method depending on behavior of hygroscopic substances, and wet- and dry-bulb psychrometer, the last is apparently best suited to the requirements of the laboratory.

New test for dimensional changes in offset papers. C. G. Weber and M. N. Geib. J. Research NBS <u>19</u> , 665 (1937).	RP1054	5¢
--	--------	----

Describes a method and apparatus for determining the relative hygrometric expansivity of papers. Specimens of paper are mounted under constant tension in a cabinet in which humidity is controlled by circulating the air over the surface of suitable salt solutions exposed in open vessels inside the cabinet. Changes of length of the paper are measured by means of an optical lever, and the relative humidity of the air surrounding the specimen is measured with a wet- and dry-bulb hygrometer. The apparatus is simple in construction and operation.

C. USE OF PAPER IN PRINTING

<u>Title</u>	<u>Series</u>	<u>Price</u>
Register studies in offset lithography. C. G. Weber and R. M. Cobb. BS J. Research <u>9</u> , 427 (1932).	RP430	OP
Information on factors affecting the register of prints, the most serious problem encountered in offset lithography, has been obtained by making experimental printings in a commercial plant under routine operating conditions. The history, composition, and properties of the papers used are described, the technique used in plant studies is outlined, and the effects of the important factors influencing the closeness of register, as determined by the experimental printings, are discussed in detail.		
Relation of paper properties to printing quality. C. G. Weber. Paper Industry <u>15</u> , No. 8 (Nov. 1933). OP.		
Information on current studies of paper problems related to the printing process requirements are presented for non-technical readers. Some typical problems are discussed, methods of attack are mentioned, and progress is shown. The article was requested for publication in a trade journal.		
Reactions of lithographic papers to variations in humidity and temperature. C. G. Weber and L. W. Snyder. BS J. Research <u>12</u> , 53 (1934).	RP633	OP
Measurements were made on papers of known response to offset lithography to determine their reactions to changes in relative humidity for a range of 27 to 72 1/2 percent relative humidity with constant temperature, and a range of 63° to 110° F temperature with constant relative humidity. The influence of changes in relative humidity and temperature on moisture content, and the effects of moisture content variations on dimensions were determined. Information on the rate of conditioning and on the hysteresis effects of adsorption, and the physical strength properties were determined at the different humidities. The reaction of the papers to atmospheric changes was correlated with the results of previous experimental printings. Recommendations are made for handling paper in lithographic plants.		
Relation of paper properties to register in offset lithography. C. G. Weber. J. Research NBS <u>13</u> , 609 (1934).	RP730	OP
Papers of known history, in the manufacture of which the fiber properties were carefully controlled, were tested in the laboratory and printed on a commercial press. The relation-		

<u>Title</u>	<u>Series</u>	<u>Price</u>
ship between fiber properties and distortion of paper and misregister in offset printing was studied. Previous studies had been made using papers from one mill, of fiber from the same source. In this later study, additional information was obtained. By using papers made according to recommended practice, in three different commercial mills, of pulps from widely different sources, sufficient information to permit general conclusions with respect to chemical wood offset papers was obtained.		
Expansion and treatment of offset papers. C. G. Weber. Paper Mill and Wood Pulp News <u>58</u>, No. 29 (July 20, 1935). A stenographic report of an address delivered at the Sixteenth Annual Convention of the American Paper and Pulp Mill Superintendents Association. Contains data on the effects of fiber formation and paper conditioning on the register of prints in multicolor offset printing.		
The treatment of offset papers for optimum register. C. G. Weber and M. N. Geib. J. Research NBS <u>16</u>, 93 (1936). This article reports results obtained in a study of the relation of hygrometric condition of paper to its behavior in offset color printing. Data on moisture content changes during multicolor printing are correlated with the register of successive color prints. Recommendations are made relative to the preparation of offset papers for optimum register in both air conditioned plants and plants without conditioning.	RP859	5¢
Bureau of Standards studies determine press room conditioning requirements. C. G. Weber. Heating, Piping, and Air Conditioning (March 1936). OP. Air conditioning for multicolor offset printing is discussed, particularly for lithographers considering new installations, and engineers and manufacturers making installations. Special air conditioning problems of the offset printer are pointed out, and good practice with respect to the conditioning of paper for multicolor offset printing is suggested.		
Air conditioning requirements of multicolor offset printing. C. G. Weber. Refrigerating Engineering <u>32</u>, No. 6, 393 (Dec. 1936). OP. Contains information on the relation of hygrometric condition of paper to register in color printing, and outlines the air conditioning requirements of multicolor offset printing.		

<u>Title</u>	<u>Series</u>	<u>Price</u>
Printing tests of experimental book papers. M. B. Shaw and R. H. Simmons. J. Research NBS <u>22</u> , No. 3, 285 (1939). Data are given on the comparative printing quality of 45 of the experimental papers manufactured in a recent study entitled "Effect of filling and sizing materials on stability of book papers". Laboratory tests of printing smoothness, oil penetration, and air permeability were made at the Bureau; actual printing trials at the Government Printing Office, by the letterpress and offset processes. The results are re- ported as supplemental to the earlier publication.	RP1180	5¢
Some of the paper problems in multicolor offset printing. C. G. Weber. Paper Trade J. <u>109</u> , No. 16, 29 (Oct. 19, 1939). This article summarizes information on the manufacture and treatment of offset papers for optimum register of color prints. The relationship between paper properties is dis- cussed, and the importance of moisture content control is shown. Recommendations are made relative to the preparation of papers and their treatment in printing plants.		
Method of conditioning paper for multicolor offset printing. C. G. Weber and M. N. Geib. Technical Bulletin No. 3 (1940), Lithographic Technical Foundation, 220 East 42nd St., New York, N. Y., price \$2.00 to non-members. Previous publications have contained data on the relation of hygrometric condition of paper to its behavior in multi- color offset printing and the optimum moisture condition for multicolor printing was established. This article describes a recently-developed method of conditioning papers to obtain the optimum moisture content, using the conventional type of conditioning machine with some modifications.		
Air conditioning in printing. C. G. Weber. Refrigerating Data Book, Chapter 56, p. 376 (1940), American Society of Refrigerating Engineers, 37 West 39th St., New York, N. Y. This article was prepared as a section of the Refrigerat- ing Data Book. It describes the application of air condition- ing to the printing industry, and outlines the specific requirements of each of the different kinds of printing in common use. The manuscript was prepared in response to a request from the American Society of Refrigerating Engineers.		
Control of paper expansion in multicolor lithography. C. G. Weber. Paper Trade J. <u>112</u> , No. 10, 31 (March 6, 1941).		

Title

Series Price

This article describes the new method of conditioning offset papers developed in connection with the research on lithographic papers. The method facilitates the correct adjustment of the moisture content of paper and greatly increases the capacity of the conventional machine by increasing the rate of conditioning. It has been successfully applied in commercial-scale operation.

Apparatus for conditioning paper. C. G. Weber and M. N.

Geib, assignors to the Government of the United States.

U. S. Patent No. 2,256,507 (Sept. 23, 1941).

This invention relates to a simple and inexpensive means of adjusting the moisture content of paper to a selected value. It is particularly adapted to the efficient conditioning of paper for optimum results in multicolor offset lithography. The invention consists essentially in the use of sprays in conjunction with a conditioner, to add water in controlled amounts to the paper when conditioning in either open or closed machines. It facilitates the correct adjustment of the moisture content of papers for printing or otherwise converting or treating.

D. PERMANENCE AND PRESERVATION

1. Stability of Paper

<u>Title</u>	<u>Series</u>	<u>Price</u>
A study of purified wood fibers as a paper-making material. R. H. Rasch. BS J. Research <u>3</u> , 469 (1929). The qualities of highly purified wood fibers and commercial papers prepared from them are being investigated from the standpoint of chemical purity, color, durability and permanence; and compared with other typical papers and paper-making fibers. In order to simulate as closely as possible the deteriorating effects of natural aging, and thus determine the probable relative permanence of various types of papers and papermaking fibers, accelerated aging treatments are made and the effects measured. The results indicate that purified wood fibers are suitable for conversion into high-grade bond and permanent record papers, which have hitherto been made entirely from a high grade of rag fiber.	RP107	OP
Permanence standards for printing and writing papers. B. W. Scribner. Transactions of the A.S.M.E. <u>52</u> , No. 19 (Aug. 1930). Experience with printed and written records has shown the necessity of having adequate standards of permanency for selection of record papers. Sufficient technical knowledge is available for the formulation of such standards, and there is sufficient interest in their establishment to make such a project feasible. This paper outlines the available information on the permanence of papers and indicates how it may be applied to formulate definite technical specifications for permanence qualities.		
Light sensitivity of rosin paper-sizing material. A. E. Kimberly and J. F. G. Hicks. BS J. Research <u>6</u> , 819 (1931). The effect of light upon rosin, and compounds of rosin formed during the rosin sizing of paper was studied, both in air and in nitrogen. The rosin and rosin compounds were exposed to the light of an inclosed carbon arc lamp in quartz tubes. Changes of color in nitrogen, an inert gas, indicated that oxygen is not essential to the chemical alteration of rosin when exposed to light.	RP307	5¢
Permanence studies of current commercial book papers. J. C. Burton. BS J. Research <u>7</u> , 429 (1931).	RP349	5¢

<u>Title</u>	<u>Series</u>	<u>Price</u>
A wide variety of current book papers was tested for purity and strength, and the effects of artificial aging on these papers were studied. In general, these book papers did not have as high purity as writing papers made of the same kind and quality of fibrous materials, and did not resist the effects of accelerated aging as well. The lower permanence qualities of the book papers probably resulted from emphasis being placed on printing quality instead of permanence qualities in manufacture. The article contains a classification of book papers relative to permanence qualities.		

Accelerated aging test for paper. R. H. Rasch. RP352 10¢
BS J. Research 7, 466 (1931).

A series of Government bond and ledger papers was studied with reference to properties related to their permanence. They were tested for fiber purity, non-cellulosic components, and strength. The influence of the components of the papers on the stability was studied by subjecting the papers to the effects of heat and light and testing them for loss of strength and deterioration of fiber. The results indicate the feasibility of classifying papers relative to their stability by means of an accelerated aging test made by heating them for 72 hours at 100° C.

Estimating the stability of paper by heating. R. H. Rasch and G. O. Stone. Paper Trade J. 95, No. 4, 28 (July 28, 1932).

One of the most convenient ways for estimating the aging properties of paper is to determine the loss in folding endurance after a heat treatment in air at 100° C for 72 hours. The reproducibility of results of the test is discussed in relation to: (1) the lack of homogeneity of the structure of paper, (2) possible variations between different folding machines, (3) variations in humidity during testing, and (4) variations in oven conditions. Suggestions are offered for minimizing errors resulting from these variables, and data are included to show the degree of reproducibility to be expected.

Comparison of natural aging with accelerated aging. R. H. Rasch and B. W. Scribner. RP620 5¢
BS J. Research 11, 727 (1933).

Thirty-three papers ranging in fiber composition from 100 percent rag to 100 percent sulphite, including purified wood fiber papers, and book papers prepared from mixtures of sulphite and soda pulp were tested for chemical purity and strength after four years of normal aging. In most respects the papers showed little change. The folding endurance,

TitleSeries Price

however, underwent marked changes, in several cases decreasing to less than half of the initial figure. The papers were placed in approximately the same order of stability by normal aging tests (72 hours at 100° C) conducted four years previously. This constitutes additional evidence of the validity of the heat test as a means of estimating the relative aging quality of papers.

Relation of ink to the preservation of written records. E. W. Zimmerman, C. G. Weber and A. E. Kimberly. J. Research NBS 14, 463 (1935). RP779 5¢

Investigation of the comparative resistance of inked and uninked specimens of papers to the effects of an accelerated-aging test revealed that the rate of deterioration of writing papers was increased by the common type of writing inks. An ink made with ammonium ammonium-oxyferrigallate was found to have a minimum of deleterious effect.

Stability of motion-picture films as determined by accelerated aging. J. R. Hill and C. G. Weber. J. Research NBS 17, 871 (1936). RP950 5¢

This article presents data on the resistance to accelerated aging of motion-picture film of the safety (cellulose acetate), and theatre (cellulose nitrate) types. The acetate film was tested to determine its utility as a new material for reproducing and preserving records of permanent value, and the nitrate type was tested to find optimum conditions for care and preservation of valuable films on this material. The stability of acetate film is shown to be comparable to that of the highest quality of permanent record papers. The nitrate film was found to be comparatively unstable.

Evaluation of motion-picture film for permanent records. J. R. Hill and C. G. Weber. Misc. Pub. NBS, M158 (1937). M158 5¢

Contains data to provide those interested in the preservation of records on film slides with a standard of quality for the cellulose acetate type of film. Tests for evaluating the stability of the film are described in detail, and properties considered desirable for film to be used for permanent records are listed.

Accelerated weathering tests of mineral-surfaced asphalt shingles. H. R. Snoke and B. E. Gallup. J. Research NBS 18, 669 (1937). RP1002 10¢

TitleSeries Price

The results of the tests reported show that all of the types of failure encountered in long outdoor exposures to the most severe weather conditions can be produced by accelerated weathering in 7 months or less.

Outdoors exposures of these shingles normally require from 10 to 20 years to produce definite results, and consequently are of little value in predicting the behavior to weathering of materials currently available, since raw materials and manufacturing processes are constantly changing. The accelerated weathering test should, therefore, be of considerable value, not only to purchasers of large quantities of these materials, but to manufacturers, as a means of improving their products. The test is made by exposing the samples to continuous light and heat from a carbon-arc lamp, with intermittent water spray, then examining them for color changes, blistering, pitting and loss of granules.

The durability of fiber building papers and fiberboards relative to low-cost housing. LC502B Free
Letter Circular NBS, LC502-B (1937). NBS

A description of research on the durability of building papers and fiberboards made as part of a general study of building materials relative to their use in low-cost housing. Includes a resume of the information on fibrous building materials already obtained by the Bureau.

The accelerated aging of fiber building boards. BMS4 10¢
D. A. Jessup, S. G. Weissberg and C. G.
Weber. Building Materials and Structures
Report BMS4 (Oct. 11, 1938).

This article describes the methods of accelerated aging employed as part of the research on materials for low-cost housing to find the stability of vegetable-fiber building boards. The data on stability will be used to predict how well the boards will retain their desirable properties in use. The aging treatments include cycles of wetting, drying, freezing, and heating, followed by physical and chemical testing for extent of deterioration. Some typical test data are included.

Degradation of sulphate fiber by bleaching. B. W. Scribner.
Paper Ind. 19, No. 11, 1279 (Feb. 1938).

Tests of "kraft" envelopes, delivered to the National Government, have shown that envelopes composed of semi-bleached sulphate fibers were very unstable, while those composed of true kraft fibers, unbleached sulphate, had excellent stability. This has also been confirmed by experience with the natural aging of such envelopes. It is recommended that in the purchase of them, either unbleached sulphate fiber or resistance to an accelerated aging test be required.

Title	Series	Price
The evaluation of motion-picture films by semimicro testing. J. E. Gibson and C. G. Weber. J. Documentary Reproduction <u>1</u> , No. 3 (1938).		
This article describes test methods for determining the approximate quality and condition of motion-picture films without material damage to the films by sampling. Methods were developed for acidity, viscosity, and residual hypo which require only one small punching of film, weighing 0.007 g for each determination. This permits the testing of a record film without affecting its serviceability.		
Summary report of research at the National Bureau of Standards on materials for the reproduction of records. B. W. Scribner. Proceedings XIVth International Conference, International Federation for Documentation, Oxford (1938). International Federation for Documentation, The Hague.		
The stability and resistance to wear of photographic films and papers have been studied relative to their suitability for the reproduction of records.		
The films comprised one emulsion type with acetate base, another emulsion type with nitrate base, and a type having a viscose base impregnated with dye. After accelerated aging by heating, they were tested for resulting loss of flexibility, degradation of cellulose, and increase in acidity. Recommended practices for storage of films are included. Brief mention is made of previous similar studies of papers.		
Weathering tests of filled coating asphalts. O. G. Strieter. J. Research NBS <u>20</u> , 159 (1938).	RP1073	10¢
This article reports tests to determine the effect of various kinds and grades of commercial fillers on the weather-resisting properties of coating asphalt. A variety of asphalt-filler mixtures was prepared and their weather-resisting properties were determined by exposing them outdoors in various localities, and to the accelerated weathering test. The tests showed that suitable fillers greatly increase the life of an asphalt, although all the fillers tested did not prove equally effective. As in previous work of this kind excellent correlation between outdoor and accelerated exposures was obtained.		
Stability of the viscose type of Ozaphane photographic film. A. M. Sookne and C. G. Weber. J. Research NBS <u>21</u> , 347 (1938).	RP1134	5¢
A new type of motion-picture film was tested to find its suitability for record use. The film tested was a viscose or		

<u>Title</u>	<u>Series</u>	<u>Price</u>
regenerated cellulose sheeting with light-sensitive dye incorporated within the base instead of a sensitized emulsion coating. The article presents data on the resistance of the film to accelerated aging tests. The stability is compared with that of the acetate and the nitrate types of film.		
Summary report of research at the National Bureau of Standards on the stability and preservation of records on photographic film. B. W. Scribner. Misc. Pub. NBS, M162 (1939).	M162	10¢
Investigations of photographic films made as part of the Bureau's general studies of the preservation of records are summarized. The various kinds of films used for documentary purposes were subjected to accelerated aging by heating, followed by tests for decrease in strength and for chemical break-down. Based on the results, the properties of film considered suitable for permanent records are specified. Exposures to light were made to find the resistance of the images to fading. Recommendations are given as to suitable storage conditions, including the special precautions for minimizing defacement of the photographic images through scratching and handling.		
A comparison of accelerated aging of record papers with normal aging for eight years. B. W. Scribner. J. Research NBS <u>23</u> , No. 3, 405 (1939).	RP1241	5¢
Various grades of record papers that had been stored under normal conditions for 3 years were tested and the results are compared with test values for their original properties, and their properties after accelerated aging by heat at time of storage. The findings agree well with a retest made after 4 years of normal aging. The papers had the same relative order of stability, as shown by retention of folding endurance, under both kinds of aging. Their stability was commensurate with the chemical purity of the papers, and the same kind of chemical changes occurred during 3 years of natural aging as under the accelerated aging treatment.		

2. Preservation

<u>Title</u>	<u>Series</u>	<u>Price</u>
A survey of storage conditions in libraries relative to the preservation of records. A. E. Kimberly and J. F. G. Hicks. Misc. Pub. BS, M128 (1931).	M128	OP
A survey of leading present-day libraries was undertaken to determine the extent to which conditions of storage may be responsible for the deterioration of records and other material. The inspection stressed conditions within the book stacks relative to the control of temperature, humidity, air pollution, and the exclusion of light, all of which are recognized as important factors. It was found that while the effects of light and dust were well guarded against in general, no library was able to control adequately the variation of temperature and relative humidity, and none attempted to minimize acidic pollution of the air. In view of these conditions, and of corroborating laboratory experiments, optimum conditions of air purity, temperature, and illumination were formulated and means of obtaining them suggested.		
Deteriorative effect of sulphur dioxide upon paper in an atmosphere of constant humidity and temperature. A. E. Kimberly. BS J. Research 3, 159 (1932).	RP407	5¢
Fourteen different commercial book and writing papers were exposed for 240 hours to the action of an air-sulphur dioxide mixture, containing 2 - 9 parts sulphur dioxide per million parts of air, at 30° C and 65 percent relative humidity. Comparison of the physical and chemical characteristics of the papers before and after exposure showed that the test specimens had materially deteriorated. The data obtained indicated that the modified celluloses in the papers were the main point of attack. This is one phase of research to find the effect of atmospheric components on records stored in libraries.		
A study of the removal of sulphur dioxide from library air. A. E. Kimberly and A. L. Emley. Misc. Pub. BS, M142 (1933).	M142	5¢
Tests made in the Folger Shakespeare Library, Washington, D. C., showed that sulphur dioxide, which is harmful to paper, was not completely removed from the air by washing it with untreated water in an air conditioning system of the usual type. Effective elimination was obtained, however, on washing the air with water that had been treated with alkaline material at a rate sufficient to maintain the hydrogen ion concentration of the wash water within the range pH 8.5 to 9.0.		

<u>Title</u>	<u>Series</u>	<u>Price</u>
The sulphur dioxide content of the washed air was found to be entirely dependent upon the hydrogen ion concentration of the wash water. The composition of a mixture of chemicals satisfactory for the treatment of the water is given.		
Preservation of newspaper records. B. W. Scribner. Misc. Pub. NBS, M145 (1934).	M145	5¢
Contains information obtained in an examination of newspapers published in the United States as far back as 1830. Relative condition of papers of different kinds of fibers is pointed out and methods of preserving current newspaper records by retarding decay of the papers and by reproduction are suggested.		
The preservation of records in libraries. B. W. Scribner. Library Quarterly 4, No. 3, 371 (July 1934).		
A resume of the results of research at the Bureau of Standards during the past four years. Light, adverse temperature and humidity, acidic pollution of the air, and low-grade paper were found to be largely responsible for deterioration of records. Recommendations respecting protective measures are included.		
Effects of fumigants on paper. C. G. Weber, M. B. Shaw and E. A. Back. J. Research NBS 15, 271 (1935).	RP828	5¢
Some valuable Government records require fumigation prior to placing in The National Archives Building, to rid them of destructive insects. Since no information relative to the effects of fumigants on paper was available, the Archivist requested tests by the Bureau. Representative book and writing papers were fumigated with five widely-used fumigants and the effects of each fumigant determined.		
Care of film slides and motion-picture films in libraries. C. G. Weber and J. R. Hill. J. Research NBS 17, 753 (1936).	RP942	5¢
The film used for records is of the safety type and as it is no more flammable than books, it offers no new problems in fire protection. However, the safety film is quite sensitive to moisture changes and is brittle when dry. It is pointed out that satisfactory service requires that the moisture content be controlled by air conditioning in the storage rooms or vaults. The ordinary type of motion-picture films have a base of cellulose nitrate which is highly combustible. The storage of this type of film presents difficult problems of fire protection, and should not be undertaken by one not entirely familiar with the problems.		

<u>Title</u>	<u>Series</u>	<u>Price</u>
Summary report of Bureau of Standards research on preservation of records. A. E. Kimberly and B. W. Scribner. Misc. Pub. NBS, M154 (1937).	M154	10¢

A summary of the results of a series of studies relating to the preservation of records, extending over the period 1929-1936, is given. A survey of library storage conditions indicated improper illumination, extremes in temperature and humidity, acidic air, and poor paper, to be deteriorative influences. Investigations led to recommended practices for minimizing their effects. Information on the protection of papers against insects by fumigation, and on increasing their resistance to wear by use of transparent sheetings is included.

Ordinary writing ink was found to be deteriorative to all record papers, but another type had little harmful effect. Studies of reproduction of records revealed that photographic prints on stable paper are suitable, and that cellulose acetate film offers considerable promise for the purpose.

This is a revision of Miscellaneous Publication M144 and includes new material on quality of paper, insects, protective coatings, and preservation by reproduction.

Air treatment for preservation of records in libraries. B. W. Scribner. Refrigerating Eng. 33, No. 4 (April 1937).

A resume of studies relative to the influence of the surrounding atmosphere on valuable books and papers stored in libraries. Extremes of temperature and humidity, acid air, and dust were found to be deteriorative to the record materials. It is recommended that if the value of the stored material warrants it, the temperature and relative humidity of library air be controlled within suitable limits, and that the air be washed with alkaline water to remove acidic gases and dirt.

The protection of documents with cellulose acetate sheeting. B. W. Scribner. Misc. Pub. NBS, M168 (1940).	M168	5¢
---	------	----

The lamination of paper with cellulose acetate sheetings as a means of protecting documents is now extensively practiced. An investigation was made of the quality of the sheetings employed and of various types of papers which were laminated with them by different operators. The sheetings were found to be satisfactory in laminating quality, stability, and strength. Their presence did not adversely affect the qualities of papers with which they were laminated nor did they cause clouding of photographs and distortion of signatures.

E. STANDARDIZATION

1. Quality Studies of Materials

<u>Title</u>	<u>Series</u>	<u>Price</u>
Study of commercial wall board. F. C. Clark and A. G. Durgin. Paper <u>25</u> , No. 23 (Feb. 11, 1920). OP. General discussion of classes of wall board and the tests made upon it for the War Department during the war.		
Suitability of paper and cotton bags in relation to burlap bags for sand. P. L. Houston. Paper Trade J. <u>74</u> , No. 21 (May 19, 1921). OP. According to all physical tests, as well as a weathering test, certain papers are stronger in their dry condition than either burlap or cotton, and in this respect are suitable for sand bags. Paper, however, loses its strength when it is wet, and for this reason, waterproofing is necessary. It is suggested that the paper section study the waterproofing of paper and attempt to manufacture a suitable paper by the scientific control of beating and by the use of chemicals.		
A study of case lining papers for the purpose of developing standard specifications. B. W. Scribner and F.T. Carson. Tech. Pap. BS <u>20</u> , 355 (1925-26). Investigation of waterproofed case-lining papers was made at the request of the Bureau of Foreign and Domestic Commerce, in order to develop information to aid overseas shippers in their selection of such papers. The type found most suitable was duplex asphalted kraft paper. As existing methods of testing the water resistance of such paper were found inadequate, a suitable test method was developed through special research. This "Ground Glass" method is considered satisfactory for this purpose. Specifications of water resistance, strength, and weight were formulated, which are believed to define paper of suitable quality.	T312	5¢
The spotting of plated and finished metals. W. P. Barrows. BS J. Research <u>2</u> , 1085 (1929). The results of a study of "spotting out" of plated metal finishes are reported. The kinds of spotting defects were studied relative to the nature and causes of the defects and methods of control were investigated. Numerous protective coverings were tested, including anti-tarnish papers and cellulose lacquers.	RP72	10¢

- | <u>Title</u> | <u>Series</u> | <u>Price</u> |
|--|---------------|--------------|
| Envelope paper qualities and their determination. B. W. Scribner. Envelope Industry <u>2</u> , No. 10; <u>3</u> , No. 1 (Dec. 1928; March 1929). OP. | | |
| This article was prepared more especially for the non-technical reader. The requirements of mailing envelope papers in respect to both processing and service are discussed in detail. Simple methods of determining the paper qualities are described and references are given to information on more exact laboratory methods. The general qualities of envelope papers are indicated by the inclusion of Government specifications. | | |
| A study of sheathing papers. F. T. Carson and F. V. Worthington. BS J. Research <u>3</u> , 75 (1929). | RP85 | OP |
| Thirty-six samples of sheathing paper were tested. Weight and thickness bear no definite relation to each other or to other properties except in papers of like structure. Thickness is no criterion of strength. Many of the heavier papers are comparatively weak. The papers differ greatly in strength retention after wetting. Less than a minute in some cases to several days in others were required for water to penetrate through the papers. Most of the papers were fairly impermeable to air, although some showed relatively large permeabilities. Relation of tests to service requirements is discussed. | | |
| Properties of fiber building boards. C. G. Weber, F. T. Carson and L. W. Snyder. Misc. Pub. BS, M132 (1931). | M132 | OP |
| Various fiber building boards consisting of representative samples of wall boards and insulating boards have been studied. The composition, manufacture, and uses of the boards are tabulated, and the different properties such as strength, density, water resistance, and expansion are discussed in detail. The test methods used are described fully and comparative properties of the two classes of boards are discussed. | | |
| A study of the physical properties of binders board. B. W. Scribner and L. W. Snyder. Paper Trade J. <u>95</u> , No. 16, 29 (Oct. 20, 1932). | | |
| In cooperation with the Binders Board Manufacturers Association, the important physical properties of binders board were studied using test samples representative of commercial products. The properties tested were thickness, density, weight, bursting strength, tensile breaking strength and elongation, and behavior under flexural stresses. Uniformity | | |

<u>Title</u>	<u>Series</u>	<u>Price</u>
of thickness and density of binding boards are both important for securing satisfactory prints on the completed book cover. The serviceability of the boards in the completed book is dependent mainly on their resistance to flexural stresses, and a simple flexural test was developed for measurement of this property.		
Properties of white Braille papers for Library of Congress publications. C. G. Weber. BS J. Research <u>12</u> , 311 (1934). A study of Braille papers used in printing for blind readers was made to assist the Library of Congress in the purchase of books for the blind. Papers in use by leading commercial Braille process printers were tested; the relationship between paper properties and printing quality was determined; and requirements for satisfactory Braille paper were recommended.	RP690	5¢
Properties of some fiber building boards of current manufacture. C. G. Weber and S. G. Weissberg. Building Materials and Structures Report BMS13 (Feb. 23, 1939). This article describes the fiber building boards that are under study in connection with a research on materials for low-cost house construction. Test data are given showing the properties of the different boards, and the test methods are described. Tests were made for thickness, density, insulating value, flexural properties, water absorption, water permeability, air permeability, linear expansion, and nail-holding strength.	BMS13	10¢
Stability of sheathing papers as determined by accelerated aging. S. G. Weissberg, D. A. Jessup, and C. G. Weber. Building Materials and Structures Report BMS35 (Dec. 22, 1939). Accelerated aging was used to determine the apparent stability of the common types of sheathing papers for the purpose of finding how well they can be expected to retain their desirable properties in service. The aging treatment included successive cycles of wetting, freezing, drying, and baking, and the effects of the cyclic treatment were observed by comparison of the properties of the papers before and after aging. The judgment of stability was based largely on the retention of resistance of the papers to the passage of water and water vapor, as they are the most important properties.	BMS35	10¢

<u>Title</u>	<u>Series</u>	<u>Price</u>
Stability of fiber building boards as determined by accelerated aging. D. A. Jessup, C. G. Weber, and S. G. Weissberg. Building Materials and Structures Report BMS50 (May 15, 1940).	BMS50	10¢

The comparative stability of 1/2-inch fiber building boards was determined by accelerated aging. The aging treatment included cycles of wetting, freezing, drying, and baking. The effects of the treatment were determined by testing the various properties of the boards before and after exposure. Judgment of the stability was based on the changes produced by aging. The accelerated aging was supplemented by exposure of specimens to outdoor conditions, and data were obtained on the resistance of the boards to several of the most common rot-producing fungi.

Stability of fiber sheathing boards as determined by accelerated aging. D. A. Jessup, C. G. Weber, and S. G. Weissberg. Building Materials and Structures Report BMS69 (Jan. 22, 1941).	BMS69	10¢
---	-------	-----

Fiber sheathing comprises fiber boards of a comparatively new type, and it gives considerable promise as a material for house construction. Samples of the boards were tested in connection with the research on building materials and structures for low-cost housing. Particular attention was given to tests of the lasting qualities of the boards and this report contains data on their resistance to accelerated aging. The changes in the properties of the materials are used as a basis for judgment of stability.

Properties and performance of fiber tile boards. D. A. Jessup, H. Bogaty, and S. G. Weissberg. Building Materials and Structures Report BMS77 (Aug. 8, 1941).	BMS77	10¢
---	-------	-----

Performance tests were conducted on fiber tile boards by subjecting them to some of the more severe conditions which might be encountered in service. Tests were made to determine the resistance of the coatings to abrasion by scouring powders, to staining agents, and to steam. Tests were also made for density, expansivity, and flexural properties of the boards, and for thickness and impact resistance of the coatings.

2. Specifications and Standards

<u>Title</u>	<u>Series</u>	<u>Price</u>
--------------	---------------	--------------

Federal Specifications for paper products are prepared by technical Committees on which all interested departments of the Government are represented. They are promulgated by the Director of Procurement. An alphabetical index of Federal Specifications can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., for fifteen cents. Copies of individual specifications are obtainable from the same source, the usual price being five cents.

A study of test methods for the purpose of developing standard specifications for paper bags for cement and lime. P. L. Houston. Tech. Pap. BS, T187 (1921).	T187	OP
--	------	----

In addition to the regular tests for paper, a special test is developed for giving numerically the stresses and strains that the paper of these bags undergo in service. This is called the resiliency or endurance test. A service test is given to determine the breaking strength of the paper when the bags are filled and dropped. Another service test is developed for determining the strength of the adhesive used in these bags. Special consideration is given the choice of best bags, as determined from these tests in determining the characteristics of a good quality bag and specifications are drawn up accordingly.

The standardization of paper. F. A. Curtis. Paper Trade J. 73, No. 17 (Oct. 26, 1921). OP.

The chief functions of standardization are elimination of waste, increase in production ability and protection of general public in trade. This paper is a discussion of the need of paper standardization, as refers to classification, definitions and the simplification of standards as well as the need of specifications which must be determined by the use to which the paper is to be put.

Report on simplification of paper sizes. Committee on Simplification of Paper Sizes. Paper Trade J. 75, No. 19, 36 (Nov. 9, 1922). OP.

Report of committee from the paper industry appointed by the Bureau of Standards to collect data and make recommendations as to the simplification of sizes of paper. The report was published by the Committee in a booklet "Suggestive Page Sizes". Numerous surveys of printed literature were made. It was found that with changes of from 1/4 to 1/2 inch,

<u>Title</u>	<u>Series</u>	<u>Price</u>
practically all literature published could be printed from four standard sheet sizes and their doubles. Recommendations are given as regards standard sizes for different kinds of paper.		
Report of the committee on the simplification of paper sizes and other data. Committee on Simplification of Paper Sizes. Booklet published by the Committee (Sept. 1923). OP.		
A resume of the work of the committee from the paper industry which collaborated with the Bureau of Standards in its work on simplification of paper. The results of an extensive survey of existing conditions as regards paper sizes for general commercial printing, for books and magazines, and for bond, writing, and ledger papers are given, and recommendations are made in regard to adoption of standard sizes. The reports of the committees on classification and definitions and on technical specifications are included and some additional data given.		
Study of the windows of window envelopes for the purpose of developing standard specifications. R. E. Lofton. Tech. Pap. BS <u>21</u> , 385 (1926-27).	T343	5¢
Gives information as to the number of window envelopes used annually; defines the different types and gives the essentials in the manufacture of the windows. Describes briefly methods of testing for transparency and gloss and gives results of tests. Specifications for quality of one-piece and two-piece windows are given, and also the Post Office Departments' regulations relating to window envelopes. Glassine and one-piece windows were found to be on the average about equal in transparency, but the latter were considerably higher in gloss. Glassine windows are more permanent in transparency than one-piece windows. Tests indicate that one-piece windows will remain practically permanent for a year or more if properly stored.		
Standards and specifications in the wood-using industry. Codes and Specifications. Misc. Pub. BS, M79 (1927).	M79	OP
Contains nationally recognized specifications and testing methods.		
National directory of commodity specifications. C. W. Ingels and A. S. McAllister. Misc. Pub. BS, M130 (1932).	M130	\$1.75

TitleSeries Price

Information on the best known specifications is given in convenient form. The book tells what specifications are in general use, by whom prepared, and where copies can be obtained. It is conveniently indexed for ready finding of purchase specifications prepared by Federal and other consumer groups, and by technical societies and trade associations. Contents include a thoroughly classified list of specifications for all types of commodities, and directions for obtaining copies of all specifications listed.

Standards for paper towels. B. W. Scribner C407 5¢
and R. W. Carr. Circ. NBS, C407 (1935).

Contains information on quality standards of paper towels relative to their purchase. Their components and properties are discussed relative to serviceability. Tensile strength and time of absorption of water are considered to be the most important properties. Investigation disclosed that the water absorptiveness decreased greatly during six-months storage, and that the decrease can be approximated by heating the towels for 1 hour at 100° C.

Letter Circulars containing a list of Simplified Practice Recommendations and a list of Commercial Standards are available, without charge, from the National Bureau of Standards, Washington, D. C.

F. MISCELLANEOUS

1. Utilization of Waste Liquors

<u>Title</u>	<u>Series</u>	<u>Price</u>
Durability of sole leather filled with sulphite cellulose extract. R. C. Bowker. Tech. Pap. BS <u>16</u>, 495 (1921-22). Leathers filled with sulphite cellulose extract and with the ordinary tanning materials were prepared and tested. The data obtained from actual service tests failed to disclose any difference in quality between the two types of leather.	T215	5¢
Use of sulphite cellulose extract as a tanning material. E. L. Wallace and R. C. Bowker. Tech. Pap. BS <u>21</u>, 309 (1926-27). Gives results of a study of the suitability of sulphite cellulose extracts derived from waste sulphite liquors, for use in tanning hides. Various extracts were analyzed for tannin content in comparison with ordinary vegetable tanning materials, and information regarding the combination of tannins in these extracts with hide substance is presented. It is concluded that sulphite cellulose extracts are suitable for use in the tanning processes, and may be substituted for more costly materials.	T339	30¢
Influence of some sulphur-containing tanning materials on the deterioration of vegetable-tanned leathers by sulphuric acid. E. L. Wallace, J. R. Kanagy, and C. L. Critchfield. J. Research NBS <u>15</u>, 369 (1935). The influence of tanning materials derived from waste sulphite liquor on the deterioration of leather was studied. Leather was tanned in the Bureau experimental tannery with the so-called "sulphite cellulose extract" and with other sulphur-containing materials and tested to find whether material decrease in tensile strength had occurred after storage for periods ranging from 2 to 24 months. In all cases, the leather appeared to have aged normally when compared with previous lots of leathers tanned without the use of sulphur-containing materials.	RP835	5¢



2. Miscellaneous Articles on Paper and Allied Subjects

<u>Title</u>	<u>Series</u>	<u>Price</u>
War time uses of paper. A. G. Durgin. Paper <u>24</u> , No. 14 (June 11, 18, 1919). OP.		
This is a discussion of the work of the Bureau of Standards on various war problems. It includes: the testing of wall board (see Clark and Conley); the production of a paper to be used in gas masks as a protection against smokes; the use of paper as a substitute for cotton and as surgical bandages (crepe paper bandages); special paper for transportation purposes, such as TNT liners; waterproof labels, etc.; paper sacking; paper for powder containers, and for use in hand grenades and cartridge boxes; waterproof plug for shrapnel shell; airplane fabrics (a substitute for linen and cotton). The report also discusses various uses of paper by the Central Powers, especially their paper textiles.		
A further discussion of some of these subjects may be found in Miscellaneous Publications of the Bureau of Standards, M46 (1921), entitled "War work of the Bureau of Standards", p. 196-202, OP. The topics covered are: wall and plaster board; paper as a substitute for linen in airplane construction; paper filter for gas masks; paper containers for axle grease and saddle soap.		
Equipment and research work of the Bureau of Standards Paper Mill. M. B. Shaw. Paper Trade J. <u>89</u> , No. 19, 60 (Nov. 7, 1929).		
The laboratory and semi-commercial equipment used for study of papermaking problems is described in detail and illustrated with photographs. The results obtained with the equipment are mentioned, and current work is described briefly.		
Mechanism of heat flow in fibrous materials. J. L. Finck. BS J. Research <u>5</u> , 973 (1930).	RP243	OP
A systematic investigation of the thermal conductivities of specimens composed of fibrous materials has been made. The experiments were designed to show the effects of such factors as density of packing, arrangement of fibers, kind and size of fibers, moisture content, air convection, and radiation on the resultant conductivity of the specimens. Data on various mixtures of fibers were obtained, and it was found that in most cases the conductivity of the mixture lies between those of the constituents, taking the conductivity of each constituent which corresponds to a density equal to the density of the mixture.		

<u>Title</u>	<u>Series</u>	<u>Price</u>
A summary of the research work of the experimental paper mill of the National Bureau of Standards. M. B. Shaw. Paper Ind. <u>17</u>, No. 5 (August 1935). The accomplishments in the experimental paper mill of the Bureau are reviewed and the semicommercial machinery is compared with the test tubes of the chemist.- Fibrous materials are studied to find the value of new materials as compared with those in use, and nonfibrous materials used in filling, coating, and sizing are studied to find their relative values, and to assist in finding optimum practice in their use. Papermaking processes are studied, and manufacturing practices recommended as a consequence of studies made have been adopted by commercial mills with improved quality of products and reduced manufacturing costs.		
Directory of commercial testing and college research laboratories. A. E. Rapuzzi and A. S. McAllister. Misc. Pub. NBS, M171 (1942). A list of the commercial testing laboratories throughout the country, together with indications of the types of commodities which they are willing and able to test. Information is given concerning 244 commercial testing laboratories, with 71 branch laboratories. There is also presented a list of the laboratories of 199 colleges used to considerable extent for research.	M171	15¢
Sound absorption coefficients of the more common acoustic materials. V. L. Chrisler. Letter Circular NBS, LC632 (1941). Contains data on the sound absorption of a number of acoustical materials including several fiber boards.	LC632	Free NBS
An easily constructed, rugged, sensitive thermopile. H. F. Launer. The Review of Scientific Instruments <u>11</u>, No. 3, 98 (March 1940). A thermopile consisting of chromel p -constantan junctions is described. Since the thermoelectric power of this couple is relatively high (over 60 microvolts per degree C) and since the metals have a low thermal conductivity and are easily worked, a sensitive, rugged thermopile may be constructed to meet individual needs in a short time without previous experience. A very simple technique of construction is described and the characteristics of a finished instrument are given.		

<u>Title</u>	<u>Series</u>	<u>Price</u>
Inks. C. E. Waters. Circ. NBS, C426 (Aug. 7, 1940).	C426	15¢

This circular outlines briefly the history of writing inks, in particular those of the iron gallotannate type, gives formulas for a few of these inks and for three iron gallate inks, discusses the aging of writing, the restoration of faded writing, the freezing of inks, and the effect of inks upon paper. Short discussions, with formulas, of other kinds of inks, including colored writing inks, drawing, stamp-pad, recording-instrument, and others are included.

Typewriter ribbons and carbon paper. C. E. Waters. Circ. NBS, C431 (June 14, 1941).	C431	10¢
---	------	-----

This circular gives general information about the manufacture of typewriter ribbons and carbon paper, and tells about the methods for testing them. The materials used and the principles involved in making the ink for ribbons and the coating for carbon paper are discussed. No formulas are given for either the ink or the coating because none that can be regarded as up-to-date are available. There is a section on the typewriter and some information is given about the hectograph.

3. Lists of Other Bureau Publications

<u>Title</u>	<u>Series</u>	<u>Price</u>
Publications of the Bureau of Standards (1901-1925). Circ. BS, C24 (1925).	C24	25¢

This circular gives a complete list of the scientific papers, circulars, handbooks, and miscellaneous publications of the Bureau to June 30, 1925.

Supplementary list of publications of the Bureau of Standards (July 1, 1925, to Dec. 31, 1931).		25¢
---	--	-----

This is a supplementary list of publications of the Bureau up to Dec. 31, 1931. It contains information on depository libraries and status of publications.

Supplementary list of publications of the National Bureau of Standards (Jan. 1, 1932, to June 30, 1936).		5¢
--	--	----

Services of the National Bureau of Standards to the consumer. R. A. Martino. Published by the National Bureau of Standards.		Free NBS
---	--	-------------

Contains numerous illustrations of equipment and devices used at the Bureau to evaluate commodities commonly purchased by the consuming public and describes in popular language the Bureau's work in the field of consumer goods. The text includes brief items telling what has been done to improve such varied products as automobiles, dental materials, dry cells and batteries, electric lamps, house heating appliances, insulation, leather, paint, paper, rubber, shoes, tableware, textiles, weights and measures devices, and many other things. References to existing Bureau circulars or papers are included. In addition, information is given about the establishment of commercial standards and simplified practice recommendations covering many commodities of consumer interest, as well as brief outlines of the certification and labeling plans inaugurated by the Bureau to assist both large-contract and over-the-counter buyers.

Organic plastics. G. M. Kline. Circ. NBS, C411 (1936).	C411	5¢
---	------	----

This circular presents a summary of information regarding those organic plastics which are of chief industrial significance, including raw materials, chemical methods involved, methods of processing, and some important applications. Selected references to the literature on plastics are included.

LC-690,pF-31.

<u>Title</u>	<u>Series</u>	<u>Price</u>
Publications relating to dyes. R. K. Worner. Letter Circular NBS, LC392 (1938).	LC392	Free NBS

This letter circular lists the publications relating to dyes written by or in cooperation with members of the staff of the National Bureau of Standards.

SUBJECT INDEX

Adhesives, coating	A-21, 22, 23, 24
Bleaching	D-13
Carao	A-12
Casein	A-24
Clays	A-21, 24
Commercial standards	E-22
Conditioning	C-1, 2, 3, 4
Cornstalks	A-13
Cotton stalks	A-10
Equipment of the Paper Section	F-20, 21
Esparto	A-11
Felts, roofing	A-32; D-12, 14
Felts, paper machine	A-30
Flax, seed flax straw	A-10
Flax, New Zealand	A-13
Glue	A-21, 22, 23
Grass	A-11
Hydrogen ion control	A-30
Ink	D-12; F-22
Manila rope waste	A-11
Minerals, coating and filler	A-21, 23, 24, 25
Laboratories, commercial	F-21
Odors from pulp mills	A-32
Organization of Bureau	A-2
Paper	
Antitarnish	E-10
Bags	E-10, 20
Boards	A-31; D-13; E-10, 11, 12, 13
Braille	E-12
Carbon	F-22
Condenser	A-30
Currency	A-31; B-35
Case lining	E-10
Envelope	E-11, 21
Gummed	B-36
Offset, lithographic	A-32; C-1, 2, 3, 4
Sheathing	E-11
Towels	E-22
Paraffin, recovery	A-20
Permanence	A-13, 14; D-10, 11, 13, 14, 15, 20, 21, 22
Plastics, organic	F-30
Preservation of records	D-13, 14, 15, 20, 21, 22
Printing and paper	C-1, 2, 3, 4
Publications, NBS	F-30
Purified wood fibers	A-13; D-10
Rayon as papermaking material	A-12
Rubber latex	A-20
Simplified practice recommendations	E-22

SUBJECT INDEX - 2

Sizes, simplification	E-20, 21
Sizing	A-23, 25; B-60, 61; D-10
Specifications	E-20, 21, 22
Sulphite pulp, stability	A-30
Tanning extracts from waste liquor	F-10
Thermal conductivity	F-20
Testing	
Absorbency	B-60, 63
Acidity	B-22, 30
Adhesive strength	B-36
Brittleness	B-31
Bulk	B-33
Bursting strength	B-31, 34
Cellulose	B-20, 21, 22
Chemical methods	B-20, 21, 22
Color	B-50, 52, 53, 54
Copper number	B-20
Curl	B-35
Expansivity	B-36
Extractor and friction cleanser	B-20, 34
Fiber analyses	B-40, 41
Folding endurance	B-32, 33, 34, 36
General	B-10
Gloss	B-50, 53
Humidity effects	B-70, 71; C-1, 2, 3
Impact	B-32
Instruments, calibration	B-33, 34, 35
Microscopy	B-40, 41
Opacity	B-50, 51, 52, 54
Optical	B-50, 51, 52, 53, 54, 55
Permeability	B-60, 61, 62, 63
Pulp testing	B-10, 52
Resin	B-21
Sizing	A-22, 25; B-20, 60, 61, 62
Stability	D-10, 11, 12, 13, 14, 15
Stains, fiber	B-40, 41
Tear	B-30, 32
Tensile	B-30, 31, 33
Thickness	B-30, 35
Water resistance	A-23; B-60, 61, 62
Wet rub	B-31
Waste materials	A-11, 12, 20; F-10

AUTHOR INDEX

Back, E.A. D-21
 Barrows, W.P. E-10
 Bell, R.W. A-24
 Bicking, G.W. . . A-10, 11, 12, 13, 14, 20, 21, 22, 23, 24, 30, 31, 32; B-10
 Bogaty, E. E-13
 Bowker, R.C. F-10
 Brode, W.R. B-20
 Burton, J.O. B-20; D-10
 Carr, R.W. E-22
 Carson, F.T. . . A-20; B-10, 20, 31, 32, 33, 34, 35, 60, 61, 62, 63, 70, 71;
 E-10, 11
 Chrisler, V.L. F-21
 Clark, F.C. A-30; E-10
 Cobb, R.M. C-1
 Costello, C.J. B-31
 Critchfield, C.L. F-10
 Curtis, F.A. E-20
 Durgin, A.G. A-30; E-10; F-20
 Eckhardt, H.C. B-32
 Emley, A.L. D-20
 Finck, J.L. F-20
 Gallup, B.E. D-12
 Geib, M.N. A-32; B-71; C-2, 3, 4
 Gibson, J.E. D-14
 Gibson, K.S. B-53
 Gottschalk, V.H. A-21, 22
 Gould, S.P. A-24
 Hamill, G.K. A-22, 23
 Hicks, J.F.G. D-10, 20
 Hill, J.R. D-12, 21
 Houston, P.L. B-30, 31, 60, 70; E-10, 20
 Hunter, R.S. B-52, 53, 54
 Jessup, D.A. D-13; E-12, 13
 Judd, D.B. B-50, 51, 52, 53, 54
 Kanagy, J.R. F-10
 Kellogg, E.H. A-10
 Kimberly, A.E. D-10, 12, 20, 22
 Kirkwood, R.S. B-70
 Kline, G.M. F-30
 Launer, H.F. B-21, 22, 54, 55; F-21
 Ledig, R.H. B-60
 Lewis, L.C. B-54
 Lofton, R.E. B-31, 33, 40, 41, 50; E-21
 Martino, R.A. F-30
 McAllister, A.S. F-21
 McNicholas, H.J. B-51
 Meyer, W.W. A-24

AUTHOR INDEX - 2

Merritt, M.F. B-40,41
Miller, D.R. B-30
O'Leary, M.J. A-13,14,23,24,25,32
Rapuzzi, A.E. F-21
Rasch, R.H. A-13,30;B-20;D-10,11
Rumsey, R.R. A-10,11
Scribner, B.W. B-20;D-10,11,13,14,15,21,22;E-10,11,22
Shaw, M.B. A-10,11,12,13,14,20,21,22,23,24,25,30,31,32;
 B-10;C-3;D-21;F-20,21
Simmons, R.H. C-3
Smith, W.H. A-10,20
Snock, H.R. D-12
Snyder, L.W. B-10,32,33,34;C-1;E-11
Sookne, A.M. D-14
Stone, G.O. D-11
Strieter, O.G. A-14,32;D-14
Wallace, H.L. F-10
Waters, C.E. F-22
Weber, C.G. A-13,24,31,32;B-36,71;C-1,2,3,4;
 D-12,13,14,21;E-11,12,13
Weissberg, S.G. D-13;E-12,13
Whittier, E.O. A-24
Wilson, W.K. B-22
Worner, R.K. F-31
Worthington, F.V. B-31,33,34,35,71;E-11
Zimmerman, E.W. D-12